TELEDERMATOLOGY IN MORECAMBE BAY - A STILL PHOTOGRAPHIC APPROACH

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PHOTOGRAPHY IS MY SKIN, AS MEMBRANE SEPARATING THIS FROM THAT, IT FIXES THE BETWEEN, ESTABLISHING MY LIMIT, THE ENVELOPE IN WHICH I AM.

HELEN CHADWICK 1954 - 1996

Figure F1. Mussel Beds.
Canon EF camera, Canon 300mm lens,
Fujifilm 100 ASA, shutter speed 1/60, aperture f11.

TO KATE

OFTEN WHEN I CALLED EDINBURGH
A GREY TOWN WITHOUT DARTING SUN,
IT WOULD LIGHT UP WITH YOUR BEAUTY,
A REFULGENT, WHITE-STARRED TOWN.

Edinburgh by Sorley Maclean in From Wood to Ridge (1999).
Collected Poems in Gaelic and in English Translation,
Carcanet Press Limited, Manchester.

DECLARATION

I declare that I myself have written this thesis. The studies were conceived following discussions with colleagues. Most of the data collection and analysis was my own work, but there has been photographic help from Yvonne Dickinson, and computer and data collection assistance from Katie Lewis. The work and data collection was undertaken between September 1993 and December 1998. Data analysis has been between 1996 and 1999 and statistical help was from Sally Hollis. The thesis was completed during 2001.

CHRONOLOGY

1992/3	Background reading.
1993/4	Initiation of projects.
1995	Early work on conventional still imaging and early digital imaging.
1996	Award of NHS grant to investigate telemedicine, particularly digital image transmission.
1997/8	Project in Morecambe Bay, involving three hospital centres, testing conventional photographs as management method for dermatological patients with skin tumours.
1998	Commencement of joint digital imaging project with Manchester. Commencement of clinical service at Barrow using conventional photographic imaging.
1999/2000	Final collection of data, statistical analysis, and writing of M.D. thesis.
2001	Thesis completion.

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PUBLICATIONS AND PRESENTATIONS

Publications

- Harrison, P.V., Dickinson, Y., Patefield, S. (1996) Medical illustration: past, present and future perspectives. *Lancaster and Westmorland Medical Journal.* 2, 217-221.

- Harrison, P.V., Lyon, C.C. (1997) Digital imaging and teledermatology : educational and diagnostic applications of a portable digital imaging system for the trainee dermatologist. *Clinical and Experimental Dermatology.* 22, 163-165.

- Harrison, P.V., Patefield, S., Dickinson, Y., Morgan, R., (1997) Dermatological diagnostic accuracy by conventional photography: A prelude to digital image interpretation. *Journal of Telemedicine and Telecare.* 3, (suppl 1) 105.

- Lyon, C.C. Zein, A., Honary, B., Harrison, P.V. (1997) Teledermatology: still digital image referrals from general practice. *British Journal of Dermatology.* 137, (suppl 50) 17.

- Lyon, C.C., Harrison, P. (1997) A portable digital imaging system in dermatology: diagnostic and educational implications. *Journal of Telemedicine and Telecare.* 3, (suppl 1) 81-3.

- Harrison, P.V. (1997) Still image - based dermatological diagnosis in a semi rural setting. *Journal of European Academy of Dermatology and Venereology.* 9, (suppl 1) S105.

- Andrews, S., Zein, N., Harrison, P., Honary, B. (1998) A novel halographic method for skin tumour identification. *Journal of European Academy of Dermatology and Venereology.* 11, (suppl 2) S157.

- Harrison, P.V., Dickinson, Y., Kirby, B. (1998) The use of a photographic clinic in prioritising dermatological referals. *British Journal of Dermatology.* 139, (suppl 51) 69.

Publications continued

- Harrison, P.V., Dickinson, Y., Lewis, K. (1998) Precision and accuracy data on semi-rural teledermatology utilising conventional photographic imaging. *Journal of European Academy of Dermatology and Venereology.* 11, (suppl 2) S157.

- Harrison, P.V., Dickinson, Y., Manning, D., Patefield, S. (1998) Teledermatology: a store-and-forward system in North West England. *European Telemedicine.* 79-80.

- Harrison, P.V., Kirby, B., Dickinson, Y., Schofield, R. (1998) Teledermatology - high tech or not? *Journal of Telemedicine and Telecare.* 4, (suppl 1) 31-32.

- Harrison, P., Lewis K., Patefield, S. (1998) Photographic dermatological imaging and telemedicine. *Lancaster and Westmorland Medical Journal.* 3, 12-17.

- Kirby, B., Lyon C.C., Harrison, P.V. (1998) Low cost teledermatology using Internet image transmission. *Journal of Telemedicine and Telecare.* 4, (suppl 1) 107.

- Lewis, K., Gilmour, E., Harrison, P.V., Patefield, S., Dickinson, Y., Manning, D., Griffiths, C. (1998) Digital teledermatology for skin tumours: a preliminary assessment using a receiver operating characteristics (ROC) analysis. *Journal of Telemedicine and Telecare.* 5, (suppl 1) 57-58.

- Gilmour, E., Lewis, K., Harrison, P., Patefield, S., Dickinson, Y., Manning, D., Griffiths, C. (1999) Digital teledermatology for unselected skin lesions. *British Journal of Dermatology.* 141, (suppl 55) 43.

- Harrison, P.V. (1999) Acne imaging by digital photography: a portable method of assessing patients. *Skin Research and Technology.* 5, 135.

Presentations

- Harrison, P.V., Dickinson, Y., Manning, D., Patefield, S. (1998) Teledermatology: a store-and-forward system in North West England. *European Telemedicine.* 79-80.

- Harrison, P.V., Kirby, B., Dickinson, Y., Schofield, R. (1998) Teledermatology - high tech or not? *Journal of Telemedicine and Telecare.* 4, (suppl 1) 31-32.

- Harrison, P., Lewis, K., Patefield, S. (1998) Photographic dermatological imaging and telemedicine. *Lancaster and Westmorland Medical Journal.* 3, 12-17.

- Kirby, B., Lyon, C.C., Harrison, P.V. (1998) Low cost teledermatology using Internet image transmission. *Journal of Telemedicine and Telecare.* 4, (suppl 1) 107.

- Lewis, K., Gilmour, E., Harrison, P.V., Patefield, S., Dickinson, Y., Manning, D., Griffiths, C. (1998) Digital teledermatology for skin tumours: a preliminary assessment using a receiver operating characteristics (ROC) analysis. *Journal of Telemedicine and Telecare.* 5, (suppl 1) 57-58.

- Gilmour, E., Lewis, K., Harrison, P., Patefield, S., Dickinson, Y., Manning, D., Griffiths, C. (1999) Digital teledermatology for unselected skin lesions. *British Journal of Dermatology.* 141, (suppl 55) 43.

- Harrison, P.V., (1999) Acne imaging by digital photography: a portable method of assessing patients. *Skin Research and Technology.* 5, 135.

- Harrison, P., Patefield, M., Dickinson, Y., Morgan, R. (1996) Dermatological diagnostic accuracy by conventional photography: a prelude to digital image interpretation. *Telemed 96. London.*

- Harrison, P.V., (1997) Still image-based dermatological diagnosis in a semi-rural setting. *6th Congress of the European Academy of Dermatology and Venereology. Dublin.*

- Harrison, P.V., Lyon, C.C. (1996) A portable digital imaging system in dermatology: diagnostic and educational applications. *Telemed 96. London.*

- Harrison, P., Kirby, B., Dickinson, Y., Schofield, R. (1997) Teledermatology - high tech or not? *Telemed 97. London.*

Presentations continued

- Kirby, B., Lyon, C., Harrison, P. (1997) Low cost teledermatology using Internet image transmission. *Telemed 97. London.*

- Lyon, C., Zein, A., Honary, B., Harrison, P. (1997) Teledermatology: still-image digital referals from general practice. *British Association of Dermatologists, Harrogate.*

- Andrews, S.G., Zein, N., Harrison, P.V., Honary B. (1998) A novel halographic method for skin tumour identification. *7th Congress of the European Academy of Dermatology and Venereology. Nice.*

- Harrison, P.V., Dickinson, Y., Kirby, B. (1998) The use of a photographic clinic in prioritising dermatological referrals. *British Association of Dermatologists. Brighton.*

- Harrison, P., Dickinson, Y., Lewis, K. (1998) Precision and accuracy data on semi-rural teledermatology utilising conventional photographic images. *7th Congress of the European Academy of Dermatology and Venereology. Nice.*

- Lewis, K., Gilmour, E., Harrison, P., Dickinson, Y., Manning, D., Griffiths, C. (1998) Digital teledermatology for skin tumours: a preliminary assessment using a receiver operating characteristic (ROC) analysis. *Telemed 98. London.*

- Gilmour, E., Lewis, K., Harrison, P., Patefield, S., Dickinson, Y., Manning, D., Griffiths, C. (1999) Digital teledermatology for unselected skin lesions. *British Association of Dermatologists. Edinburgh.*

- Harrison, P.V. (1999) Acne imaging by digital photography: a portable method of assessing patients. *6th Congress of the International Society for Skin Imaging. London.*

- Harrison, P.V. (1999) Teledermatology in Morecambe Bay - five years experience in 1,402 patients. *8th Congress of the European Academy of Dermatology and Venereology. Amsterdam.*

- Wong, C.S., Taylor, F., Harrison, P.V. (2000) Does teledermatology have a role in managing waiting lists for patients with benign and malignant skin tumours. *British Association of Dermatologists, London.*

- Brookes, D.B., Harrison, P.V. (2000) Willan, dermatologist of the Millennium, an industrious innovator. *British Association of Dermatologists, London.*

ABSTRACT

There have been few studies in the UK critically examining telemedicine - particularly with regard to teledermatology. Telemedicine can simply mean the practice of medicine at a distance, but is usually accepted as meaning the distant delivery of healthcare using electronic equipment and data transfer. There are different ways of achieving or undertaking telemedicine, and still photography is examined in the present work as a basis of a still, store-and-forward, telemedicine system in Morecambe Bay.

The history of dermatological illustration is described - before tracing the development of photography and medical photography, which may be used in telemedicine. The development of telemedicine as a speciality is discussed and a number of studies were undertaken, using either conventional or digital cameras, in which still photography was examined as a method of achieving dermatological telemedicine. Primarily skin tumours have been studied, partly because of lengthening dermatology waiting lists in Morecambe Bay, but also since tumours were more readily assessed in a still image-based (store-and-forward) telemedicine system.

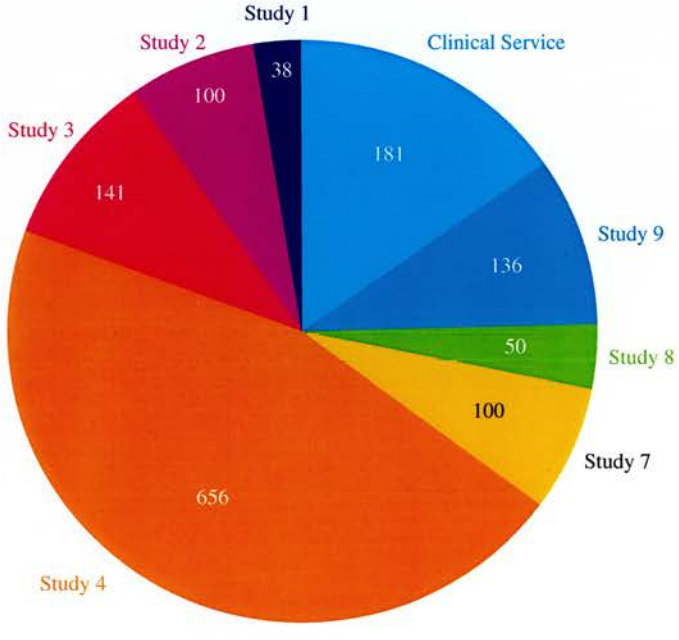
Telemedicine was examined as a means for improving access to dermatological expertise in a large geographical area, with long waiting lists in Morecambe Bay. The work has shown that telemedicine could effectively be used in dermatology, using photography (either conventionally or digital) as a method of skin tumour management. 1402 patients were studied, the diagnostic accuracy through image analysis varying from 62% to 95%. Furthermore, telemedicine methods could effectively distinguish between benign and malignant skin tumours, and there was a high degree of certainty in predicting the management of skin tumours.

Analysis of cost effectiveness revealed that teledermatology could efficiently help in the management of waiting lists in dermatology, and help in the triage of patients. A clinical service was later developed, initially based on conventional photographic imaging but later to become based on digital imaging, supported by significant patient enthusiasm and acceptance of telemedicine.

However, it is important with any telemedicine development for adequate resources for treatment, as well as diagnosis, to facilitate a comprehensive service for patients. Telemedicine in dermatology should not not be seen as a replacement for existing hospital services, but can be a very useful addition to help in patient management.

A summary of patients studied in the work is shown below (figure A1):

Figure A1. Summary of patients studied



Total 1402 patients

Within Study 4, 291 of the patients answered questionnaires in Study 5, and 75 general practitioners were sent questionnaires in Study 6.

A summary of cases (patients, questionnaires and general practitioners) is shown on Table 1:

Table 1
Summary of studies

Study	Abbreviated Title	Number of cases
1	Conventional Pilot Study A	38
2	Conventional Pilot Study B	100
3	Conventional Pilot Study C	141
4	Conventional Photography Study	656
	1st data analysis on 200 patients / 2nd data analysis on 210 patients / 3rd data anlaysis on 164 patients	
5	Patient Assessment	291
6	General Practitioner Assessment	75
7	Digital Pilot Study A	100
8	Digital Pilot Study B	50
9	ISDN-Based Teledermatology	136
-	Clinical Service	181
-	TOTAL	1768

Within study 4,291 of the patients imaged had questionnaire assessments, and 75 general practitoners were also sent questionnaires.

ABBREVIATIONS AND DEFINITIONS

Conventional photography -The use of non-digital camera systems in which photographic films are used to form the image

Diagnostic accuracy - The frequency of correct diagnoses, comparing the attempted diagnosis or diagnoses with the true diagnoses:

$$\frac{\text{True Positive}}{\text{True Positive + False Positive + False negative}}$$

Digital photography - Photography in which, digital or electronic, cameras are used and a computer chip replaces the photographic film

Face-to-face consultation - A consultation in which there is a meeting between the patient and practitioner in the same space and time

Image quality - This is a product of the resolving power of the lens, and the sensitivity of the photographic emulsion in conventional photography. The quality of a digital image is dependent on the number of pixels in the image, and the trueness of brightness and colour. In digital photography, image quality is also dependent on the screen resolution and printer quality. In both conventional and digital photography, image quality may also depend upon lens focusing and object illumination

Internet - Digital global information network or telecommunications network linking computer terminals worldwide

ISDN- Integrated Systems Digital Network. A digital network which facilitates high speed data transfer

JPEG- Joint Photographic Expert Group. A standard for digital compression of images

Modem - Hardware device that allows one computer to communicate with another computer via telephone lines

Optical resolution -	The ability of the eye, lens, or photographic emulsion to differentiate fine detail. Image resolution defines the ability of the camera to reproduce the original article. Image resolution is dependant on the camera lens (and optical qualities), but also in a conventional camera depends upon the film and in a digital camera is related to the number of pixels
Photographic accuracy -	An assessment of the degree of fidelity or likeness between an object and the photographic image of that object
Real-time telemedicine -	Telemedicine undertaken in the present time, as opposed to stored data
ROC analysis -	Receiver Operating Characteristics analysis. A standard method of comparing the assessment of images
Sensitivity -	In assessing diagnostic accuracy, the sensitivity is: $\frac{\text{True Positive}}{\text{True Positive + False Negative}}$
Specificity -	In assessing diagnostic accuracy, the specificity is: $\frac{\text{True Negative}}{\text{True Negative + False Negative}}$
Store-and-forward telemedicine -	Telemedicine undertaken with recorded material, either using text or images
Teledermatology -	The practice of telemedicine in dermatology
Teledermatologist -	A dermatologist practicing telemedicine
Telemedicine -	Either simply the practice of medicine at a distance or remote, telemetric health care, using information and communication systems to give patients and health care workers access to relevant information sources wherever they are located
VC-	Video-conferencing. A method of communication of real-time or live images, between relevant individuals or sites

STATISTICS

Statistical analysis used confidence interval analysis and was assessed using the Arvus Quick Step medical programme (Addison Wesley, Longman Ltd). Receiver operating characteristic (ROC) analysis (Hanley & McNeil, 1982; Metz 1989) was undertaken to determine decision certainty when analysing images during the last digital study (Study 9).

ROC analysis is recognised as a standard method for analysing medical images. ROC analysis, introduced initially into radiological assessments, has been adopted by telemedicine workers for statistical evaluation of images (Ferrer - Roca, 1998). The ROC curve enables a quantitative index of diagnostic accuracy when assessing images. The correspondance between the area under an ROC curve and the Wilcoxon statistic is used, and underlying Gaussian distributions are assumed in providing a table that converts observed correlations in paired ratings of images into a correlation between two ROC areas. The general approach for assessing whether the difference in the areas under two ROC curves derived from the same set of patients is random or real, is to calculate a critical ratio Z, defined as:

$$Z = \frac{A_1 - A_2}{\sqrt{SE_1^2 + SE_2^2 - 2rSE_1SE_2}}$$

Where A1 and SE1 refer to observed area and estimated standard error of the ROC area associated with modality 1; where A2 and SE2 refer to the corresponding quantities for modality 2; and where r represents the estimated correlation between A1 and A2.

PREFACE

An appreciation of art can be important in the understanding of science and the ability of photography to illustrate objects accurately has been acknowledged since the early days of photography, over a century ago. The Victorian artist (figure PR.1), philosopher, and writer John Ruskin (1819-1900), whose home was later at Brantwood, in the Lake District, described "while a photograph of a landscape is merely an amusing toy, one of early architecture is a precious historical document; and that this architecture should be taken, not merely when it presents itself under picturesque general form, but stone by stone, and sculpture by sculpture" (Ruskin, 1903a).

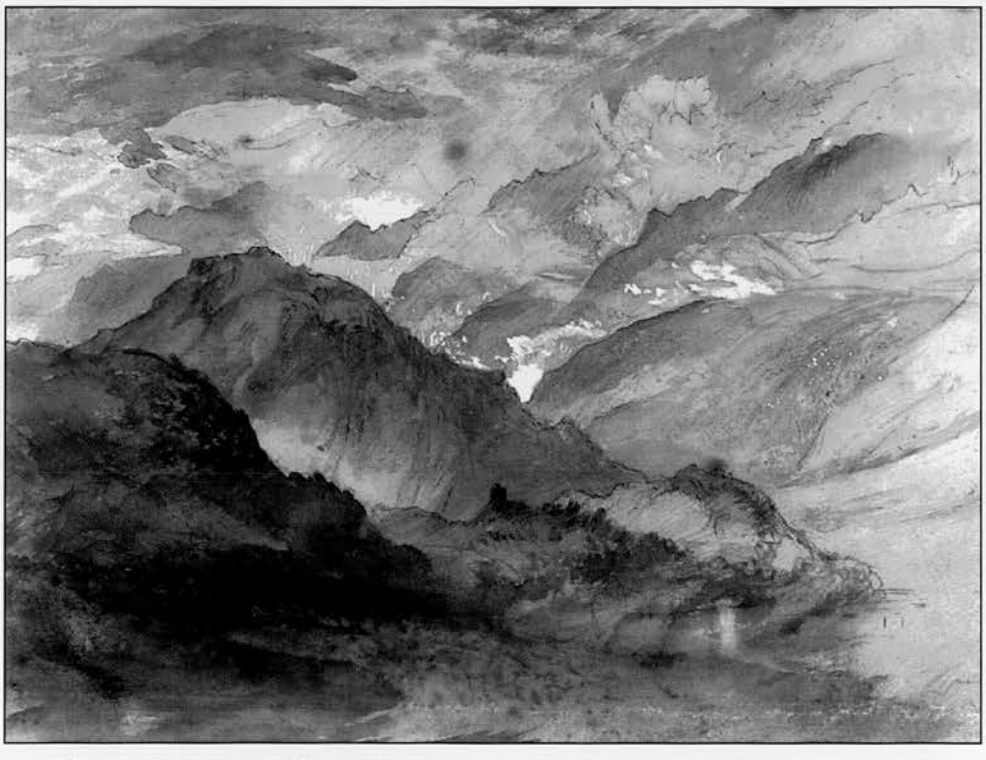


Figure PR.1.Ruskin, John. Mountain Study near Baveno, 1845.
Pencil, ink, and watercolour. 14.5 x 19.5cm.

Ruskin, describing geology (figure PR.2), wrote "to see in all mountains nothing but similar heaps of earth; in all rocks, nothing but similar concretions of solid matter; in all trees, nothing but similar accumulations of leaves, is no sign of high feeling or extended thought. The more we know, and the more we feel, the more separate; we separate to obtain a more perfect unity. Stones in the thoughts of a peasant, lie as they do on his field; one is like another and there is no connection between them. The geologist distinguishes, and in distinguishing connects them" (Ruskin, 1903b)

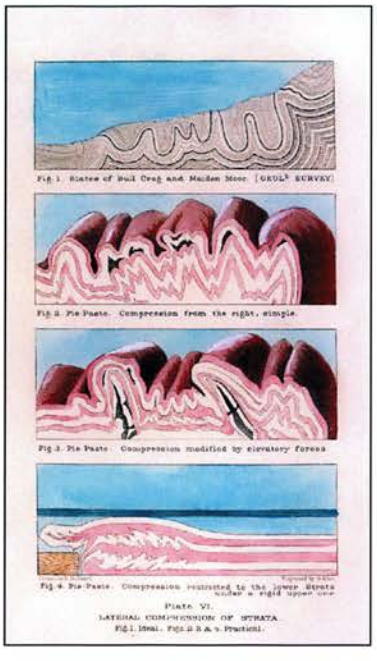


Figure PR.2.Allen, George (Engraver - after Laurence Hilliard).
Lateral compression of strata, 1878. Plate VI of Deucalion by Ruskin,
Collected studies of the Lapse of Waves, and Life of Stones, Part V.

Artists, architects, geologists and photographers interpret what they see and Ruskin, by the power of observation, acknowledged the ability to distinguish objects which may to an untrained eye look similar. Hence "there are no natural objects out of which more can thus be learned than out of stones" (Ruskin, 1893a) and "take the commonest, closest, most familiar thing, and strive to draw it verily as you see it. Be sure of this last fact, for otherwise you will find yourself continually drawing, not what you see, but what you know" (Ruskin, 1903c). The artist, just like a physician, needs powers of observation to enable the portrayal of objects (figure PR.3). Accuracy is just as important in art, as in science, and "the next characteristic of great art is that it includes the largest possible quantity of truth in the most perfect possible harmony" (Ruskin, 1864).

Figure PR.3.Lakeland Scene.
Canon EF camera, Canon 80-200mm lens,
Fujifilm 400 ASA, shutter speed 1/60, aperture f11.

In architecture, accuracy is important and "being all of them accurate record of the main architectural lines, the shapes of the shadow, and the remnants of artificial colour" (Ruskin, 1893b). Ruskin described and illustrated architecture in his work "Stones of Venice" (Ruskin, 1904). An earlier photograph by Carlo Ponti is shown below (figure PR.4):

Figure PR.4.The fourth and fifth porticos of the west front of St. Marks, Venice. Daguerreotype by Carlo Ponti, circa 1855. In: The Stones of Venice: Ruskin's Venice in Photographs, by Julie Lawson (1992), Scottish National Portrait Gallery, Edinburgh

"Every chip and stone is there - and of course there is no mistake about proportions. It was no marvel that the mind should be so deeply entranced by the visionary charm of a scene so beautiful and strange...", John Ruskin (1819-1900) Some recent observations on Edinburgh buildings (figure PR.5. to PR.8), again shown in photographs, are illustrated below, showing architectural features:

Figure PR.5.The Old College, Edinburgh. Olympus OM2 camera, 80-300mm Tamron lens, Fujifilm ASA 400, shutter speed 1/125, aperture f16.

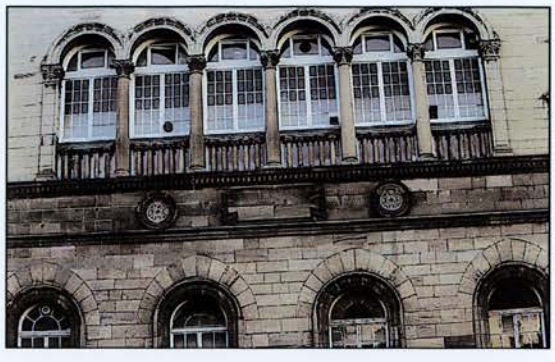


Figure PR.6.The Old College, Edinburgh. Olympus OM2 camera, 80-300mm Tamron lens, Fujifilm ASA 400, shutter speed 1/125, aperture f11.

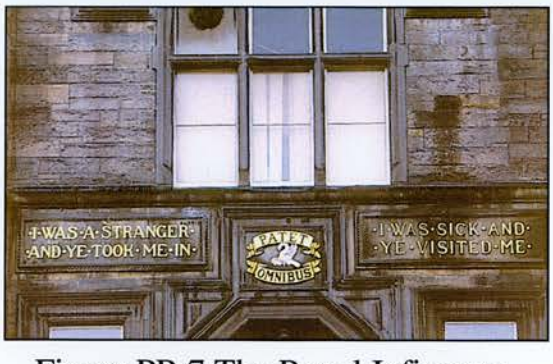


Figure PR.7.The Royal Infirmary, Edinburgh. Olympus OM2 camera, 80-300mm Tamron lens, Fujifilm ASA 400, shutter speed 1/60, aperture f16.

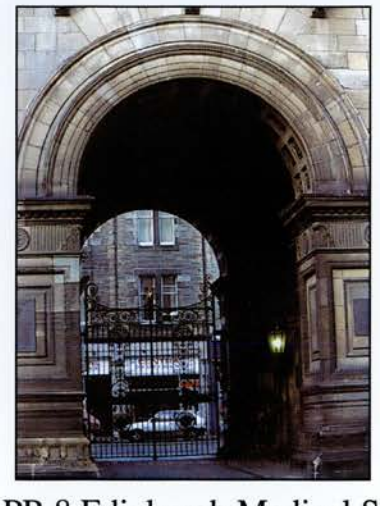


Figure PR.8.Edinburgh Medical School. Olympus OM2 camera, 80-300mm Tamron lens, Fujifilm ASA 400, shutter speed 1/125, aperture f16.

Stones, geology and architecture are relevant to the present work because of the requirement for observation in order to assess detail. The use of photography to allow images of skin lesions to be assessed has been stimulated by my own interest in photography, both artistic and scientific. In this work, still photographic imaging as a telemedicine technique has been examined for the management of dermatological problems, and dermatology requires the accurate assessment of detail.

Figure PR.9.Lancaster Sessions House and Market.
Engraved by S. Rawle after W. Westall, 1829.

The work is primarily based in Lancaster (figure PR.9), but has also included Kendal and Barrow. The Lake District has provided a link between dermatology in Morecambe Bay and Edinburgh through Willan, but it is Ruskin, now recognised as a man of art and science (Palmer, 2000), who has also provided a stimulus to the thesis through his writings and pictures, together with powers of observation (figure PR.10).

Figure PR.10.Ruskin, John. Mount Pilatus, 1854.

CHAPTER 1

INTRODUCTION

1.1 The Geography

The population of Morecambe Bay is currently about 350,000, and there are three main hospitals - Royal Lancaster Infirmary, Lancaster; Westmorland General Hospital, Kendal; and Furness General Hospital, Barrow. The population is spread over a large geographical area, and there are three main towns- Lancaster, Kendal and Barrow-in-Furness-but there is a significant rural population (figure 1.1):

Figure 1.1.Morecambe Bay.

232 general practitioners provide the primary medical care to the patients in Morecambe Bay - a mixture of city-based and rural/semi-rural practices.

Communication across the area is not easy, whether by rail or road. Patient access for medical care can also difficult, and dermatological services are located in Lancaster, Kendal and Barrow-in-Furness. The in-patient facilities, for the Morecambe Bay area, are in a new purpose-built unit at Lancaster Royal Infirmary (appendix 1). The dermatology unit at Lancaster, opened in 1998, also has out-patient facilities, where the majority of skin cancer is diagnosed and treated.

1.2 The Problem: lengthening dermatological waiting lists, and skin cancer management in a large geographical area

Presently, two consultant dermatologists cover a large geographical area in Morecambe Bay, one dermatologist per 175,000 population, and the ratio of dermatologists to population is less than that most recently recommended by the British Association of Dermatologists (1:100,000). Both locally, and nationally, waiting lists have become a problem in dermatology - and it is worrying that some skin cancer patients may face unacceptable waits for treatments. Also, the diagnostic accuracy of general practitioners, can sometimes only be 50% when dealing with skin tumours. This was observed during an assessment of diagnostic accuracy involving 300 patients attending a consultant clinic for skin tumour assessment (Harrison, 1990). The diagnostic accuracy (from referral letter details) of general practitioners was lower (50%) than that of the consultant (80%) or junior medical staff (80%), the latter dealing with more straightforward dermatological problems. Some patients with malignant skin tumours may be denied treatment because of inadequate referral letter details or inappropriate prority assigned because of a wrong or misleading diagnosis by the general practitioner. A method which improves access to dermatological expertise would be useful in helping the management of patients - of relevance in the North West of England, where there is an above average incidence of skin cancer (Skin Cancer in the North West, 1994).

Telemedicine may be one method of improving the situation in Morecambe Bay, particularly with regard to skin tumours. Still photography and image transmission are telemedicine techniques which can be applied to dermatology. Photography can record images of skin lesions, and these can be interpreted at a

distance. This approach, using both conventional and digital photography, has been examined in the present work.

It was only relatively recently that accurate illustrations, through photography, have been possible in dermatology. Prior to photographic illustration,dermatology relied upon written descriptions and later artistic interpretations led to drawings and paintings.

1.3 History of Dermatological Illustration

Early illustrative records of medical diseases were often incidental findings in the paintings of classical medieval artists. During the Middle Ages, and later, medical knowledge increased and there was a parallel enhancement of artistic techniques, with the human body becoming an object for artistic study.

More accurate reproduction of details in medicine became possible with drawings or paintings, and in the 17th Century there was introduced a realism suitable for medical illustration (Exhibition, 1997). One of the most important developments in book, and document illustration, was the introduction of lithography. This process was discovered in 1796 by Alois Senefelder (1771-1834), but, prior to this, woodcuts, engravings or etchings were used - although these produced less precise details of objects. Although colour printing was in use in the 17th Century, it was not until the 18th Century when it became more widely available for the illustration of texts.

Figure 1.2.Willan's House, near Sedbergh.

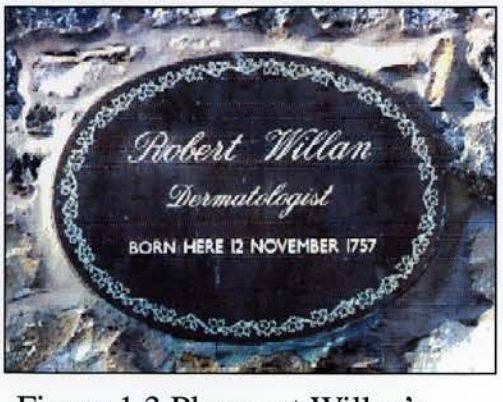


Figure 1.3.Plaque at Willan's House.

Although written descriptions of dermatological problems had been widely available for sometime, the first textbook in English to describe dermatological diseases in detail was by Turner (Turner, 1712), but there were no illustrations in this book, and it was not until the early 19th Century that dermatological illustration became more widespread. Robert Willan (1757-1812) establishes a link between images (or illustrations), Morecambe Bay and Edinburgh. Willan's family was from near Sedbergh, Cumbria (figures 1.2 and 1.3), and his books (1798 & 1808) contained early examples of dermatological illustration.

Willan's father qualified as a doctor at Edinburgh in 1745, the year of the Jacobite Rebellion, and Willan qualified MD - also at Edinburgh (figure 1.4), in 1777.

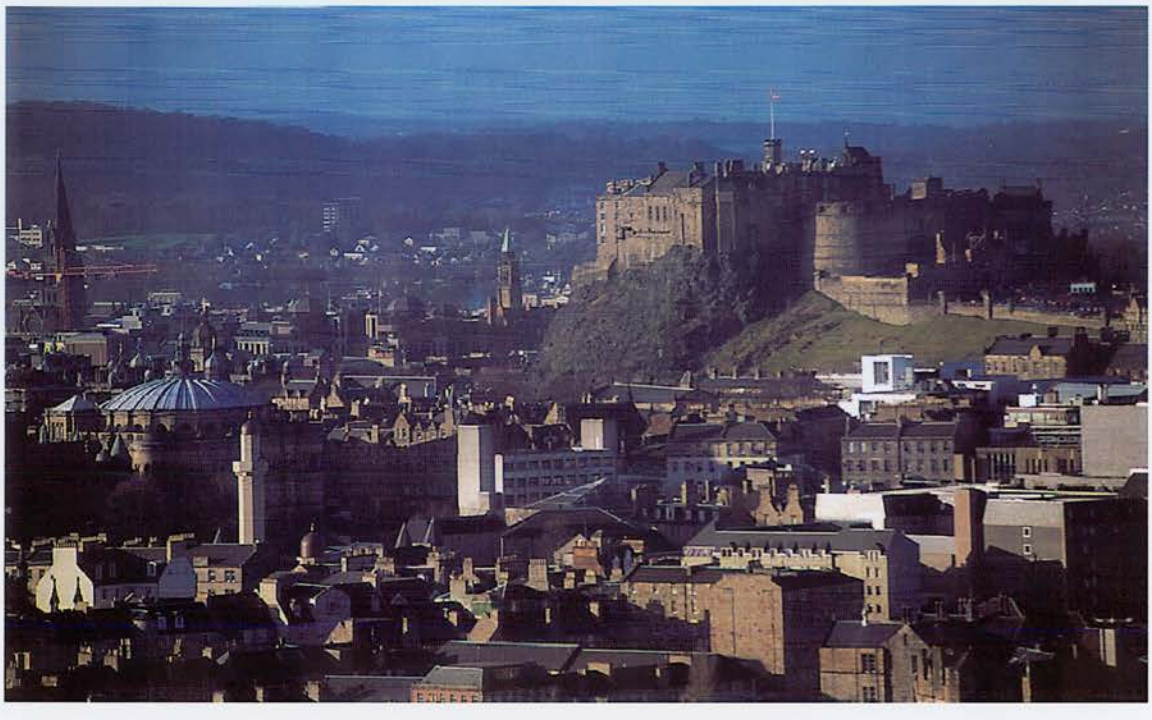


Figure 1.4.Edinburgh perspective.
Olympus OM2 camera, 80-300mm Tamron lens,
Fujifilm ASA 100, shutter speed 1/60, aperture f11.

Robert Willan also worked in London and he succeeded in introducing an early classification of skin problems. However, the quality of engravings in his works was probably superseded by Alibert, who published three books in 1806 and 1832 (without illustrations) and 1833 (Alibert 1806a, 1806b & 1832). There have since been a number of dermatological texts with illustrations and it is useful to compare Willan's early work with some later texts (table 2).

Table 2

Early dermatological texts with illustrations

AUTHOR	ILLUSTRATIONS	COMMENT
Willan, 1798, 1808	Very good colour illustrations with stippling by artist	Mostly rashes, and sometimes illustrations have an artistic nature
Alibert, 1806, 1832	Colour engravings and plates with stippling by artist	Alibert was a professor of medicine in Paris. Very good quality illustrations, mainly rashes but some tumours
Bateman, 1817	Essentially based on Willan's work.. Stippling by artists is a feature, as in Willan's work	Mostly rashes feature, and the illustrations often of an artistic nature, but generally improved quality to those of Willan
Rayer, 1835	Excellent quality colour plates using stippling by artist	Some tumours are shown in the colour atlas
Duhring, 1876	Stippling by artist features, but colour prints are of good quality	Duhring was a professor of dermatology at the University of Pennsylvania. The illustrations are of reasonable quality, but also artistic
Cazenave, 1845	With stippling by artist	A professor of medicine in Paris. Cazenave illustrated his atlases with colour prints of good quality
Wilson, 1847	Good quality illustration	Mostly rashes, but with some tumours, and the illustrations are often artistic
Hebra, 1872, 1876	Excellent colour prints with black and white line drawings	Mostly rashes, but reasonable quality The illustrations were quite artistic
Fox, 1877	Colour photographs, which were retouched by hand	Illustrations of good quality but often artistic
Hutchinson, 1878, 1888	Plates, woodcuts and drawings with some re-touched photographs	Surgeon to the London Hospital. The Illustrations are excellent in quality, showing tumours as well as rashes, and often artistic
Squire, 1878	Colour drawings and plates of moderate quality	Atlas shows rashes and no tumours
Araujo, 1883	Colour prints with some artistic stippling but also some black & white photographs	Although the prints are artistic rather than realistic, the photographs are of good quality
Le Loir & Vidal, 1889	Colour pathology plates with stippling	Of moderate quality but with no clinical illustrations
Taylor, 1889	Colour prints and line drawings. Many black & white drawings with woodcuts and engravings	A professor of dermatology in New York. His illustrations are of good quality but often artistic and showed mostly rashes. He also utilised illustrations from other books as well as using his own drawings
Unna, 1889	Mostly excellent lithographs with occasional black & white photographs	Some illustrations of artistic quality, but the lithographs are almost photographic in quality

Table 2 continued

AUTHOR	ILLUSTRATIONS	COMMENT
Neumann, 1890	Good quality plates	Neumann was a Professor of dermatology at Wein. The illustrations were often artistic in nature, showing mostly rashes rather than tumours
Pissard , 1891	Black & white photographs utilising artificial light in preference to daylight. The photographs by the author plus utilised a photographer	Pissard was a professor of dermatology in New York. Excellent quality of illustrations
Morrow, 1894, 1899	Black & white photographs with colour type technique and some colour prints	A professor of venereal diseases in New York, some of the illustrations being of an artistic nature, but photographs were good quality. However, some of the illustrations were taken from other books, eg. Kaposi (1898, 1899 & 1900) and Hutchinson (1878 & 1888)
Radcliffe-Crocker, 1893 & 1896	Excellent illustrations with drawings colour prints.	Physician in London. Illustrations were by an artist and showed some tumours
Kaposi, 1898, 1899 & 1900	Atlas with engravings plus photographs	Good quality illustrations
Pringle, 1904	Woodcuts, photo lithochromes, and black and white photographs	Good quality early photographs
Dockrell, 1905	Colour photographs, with re-touching	Reasonable quality illustrations

Early works were illustrated with engravings and illustrations, where often enhanced with the artistic technique known as stippling. Figures 1.5 and 1.6 show illustrations in Alibert's book and it is apparent, particularly on the illustration showing the facial lesion, that there is a degree of artistic interpretation which has reduced the reality of the image:

Figure 1.5.Facial skin tumour in text by Alibert (1806, 1832).

Figure 1.6.Keloid in text by Alibert (1806, 1832).

Later, Wilson, in 1847, wrote a text with illustrations of similar quality to those of Alibert. Figure 1.7 shows a keloid in Wilson's text:

Figure 1.7.Keloid in text by Wilson (1847).

Hutchinson, surgeon to the London Hospital, in 1878 described details of surgery with illustrations including plates, photographs, woodcuts and diagrams. The illustrations (excluding the photographs), were probably better quality than Willan's earlier engravings and described skin malignancies in detail (figures 1.8 and 1.9):

Figure 1.8.Basal cell carcinoma in text by Hutchinson (1878).

Figure 1.9.Malignant melanoma in text by Hutchinson (1878).

Towards the end of the 19th Century, Radcliffe-Crocker, a physician in London, introduced an atlas with excellent illustrations, showing tumours as well as rashes. Figure 1.10 shows details of basal cell carcinoma in Radcliffe-Crocker's text:

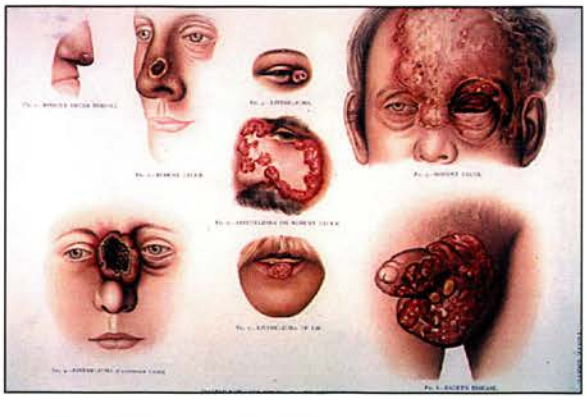


Figure 1.10.Basal cell carcinoma in text by Radcliffe-Crocker (1893, 1896).

Kaposi also produced an atlas at the end of the 19th Century showing tumours as well as rashes and included engravings of a squamous cell carcinoma and also an illustration of mycosis fungoides, plus a photograph of a basal cell carcinoma. Figure 1.11 shows a facial carcinoma in Kaposis's text:

Figure 1.11.Facial carcinoma in text by Kaposi (1898, 1899 & 1900).

Perhaps, early dermatological illustrations would have been of better quality, if expertise already gained from botanical illustrations had been more extensively used in the dermatology literature. Economic pressures could have been the reason that dermatological illustrations were later to develop than those illustrating botanical texts. In the 16th and 17th Centuries, there was much interest in plants, with some large wealthy houses having botanical collections. Also, there was interest in the pharmacological properties of many plants, which stimulated botanical illustrations. The Royal College of Physicians, in Edinburgh, contains an excellent collection of botanical texts. Clusius (1526-1609) illustrated a botanical book with simple, but accurate engravings, which were excellent when compared with later dermatological texts. (figure 1.12). A book by Colonna (1592) had more detailed copper plate etchings, and more colouring was used to illustrate plants (figure 1.13):

Figure 1.12.Illustration from botanical text by Clusius (1576).

Figure 1.13.Illustration from botanical text by Colonna (1592).

A later text by Woodville (1793), at a contemporary time with Willan, has exquisite plate engravings of flowers, with details of a superior quality to those engravings in Willan's text. A comparison between illustrations from Woodville's and Willan's texts, is shown below (figures 1.14 & 1.15):

Figure 1.14.Botanical print by Woodville (1793).

Figure 1.15.Dermatology illustration by Willan (1798, 1808).

The difference in quality between botanical and dermatological illustrations, could possibly be related to the quality of the artist, but could also signify that plants are easier to paint and are generally more uniform in colour and shape than many skin disorders. Yule in 1998 wrote about Neil Stewart, a 19th Century Edinburgh artist, who illustrated extensively both botanical and medical (particularly pathology) subjects, utilising his expertise in both sciences.

It is perhaps relevant that, when at Edinburgh, Willan came under the influence of Hope, a botanist, and Cullen, a physician - both of whom were involved in the classification of their subjects - and Willan undoubtedly would have used ideas from botanical texts for his illustrations. It is unfortunate that Willan never completed his second volume of cutaneous diseases, the posthumous task been taken up by Bateman (1817), the text accompanied by plates made from Willan's original drawings. Willan died on the island of Madeira in 1812, but has recently been posthumously nominated "Dermatologist of the Millennium", in recognition of his contribution to British dermatology.

Prior to photography, a very striking method of illustrating dermatological disease was in the form of wax representations. Although initially introduced for teaching anatomy, wax models were most popular in the mid to late 19th Century, and a number of dermatological centres, particularly in Europe, had collections of wax moulages. In Scotland, a few are preserved in The Department of Dermatology, University of Edinburgh. Some examples (from the Department of Dermatology, Wroclaw, Poland) are shown below to illustrate the detail possible with wax moulages (figures 1.16-1.18):

Figure 1.16, Moulage in collection of Department of Dermatology, Wroclaw, Poland.

Figure 1.16. Venous Ulceration.

Figure 1.17.Psoriasis.

Figure 1.18.Acne Rosacea.

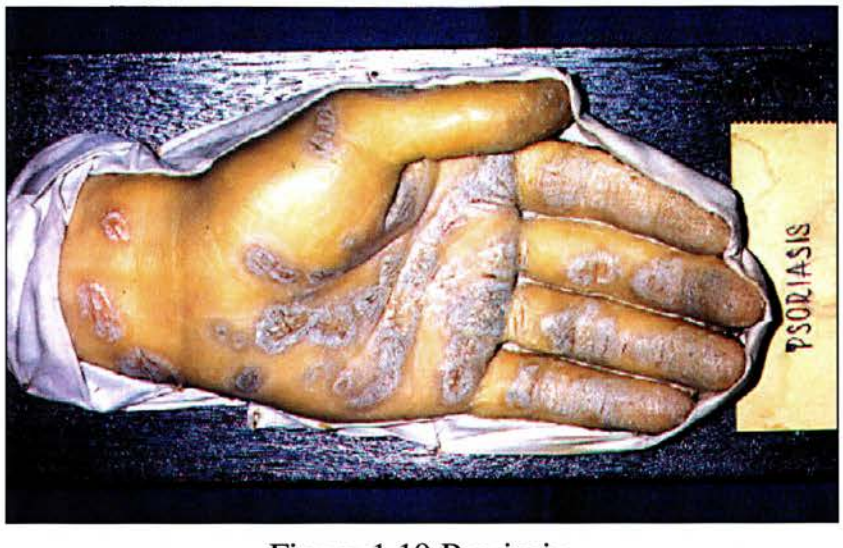


Figure 1.19.Psoriasis.

Figure 1.20. Carcinoma.

Figures 1.17-1.20, Moulages in collection at Department of Dermatology, Wroclaw, Poland.

Figure 1.21.Pemphigoid.

Figure 1.22.Carcinoma.

Figures 1.21-1.22. Moulages in collection at Department of Dermatology, Wroclaw, Poland.

An excellent review of wax models and dermatology, describing moulages in detail is by Parish et al (1991). The wax moulage technique was used in "The Portfolio of Dermachromes" by Jacobi (Jacobi, 1904), with the text describing a number of dermatological conditions.

Moulages introduced a photographic reality to dermatological illustration, but the later routine use of photography, initially black and white (Fox, 1880) and then colour (introduced in the 1930s and 1940s), enabled the truly realistic reproduction of dermatological diseases (figures 1.23-1.28):

Figure 1.23.Black & white photograph,
retouched by hand, of lupus
erythematosus in text by Pissard (1891).

Figure 1.24.Late 19th century black and white photographs, retouched by hand,
showing facial tumours in text by Morrow (1894).

Figure 1.25. Black & white photograph of lupus vulgaris from Department of Dermatology collection, Edinburgh University, 1905.

Figure 1.26.Black & white photograph of unusual hyperkeratosis ("porcupine feet"), from Department of Dermatology collection, Edinburgh University, 1906.

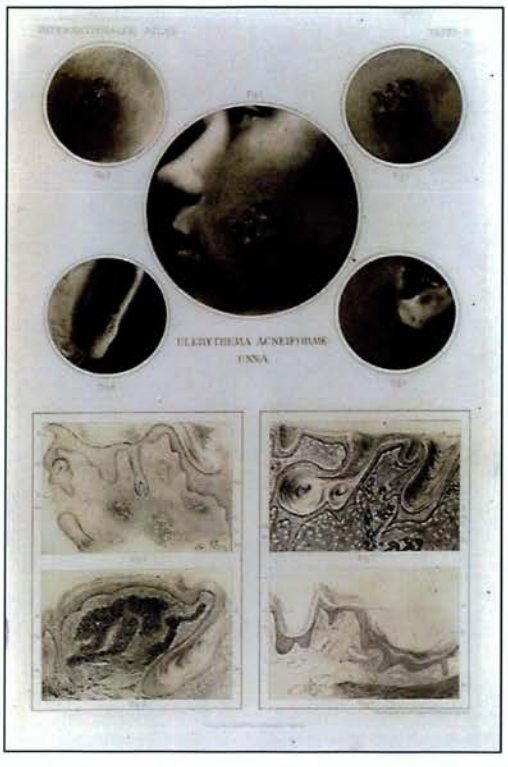


Figure 1.27.Late 19th century photograph showing clinical features and aspects of cutaneous pathology, in text by Joseph Van Deventer (1906).

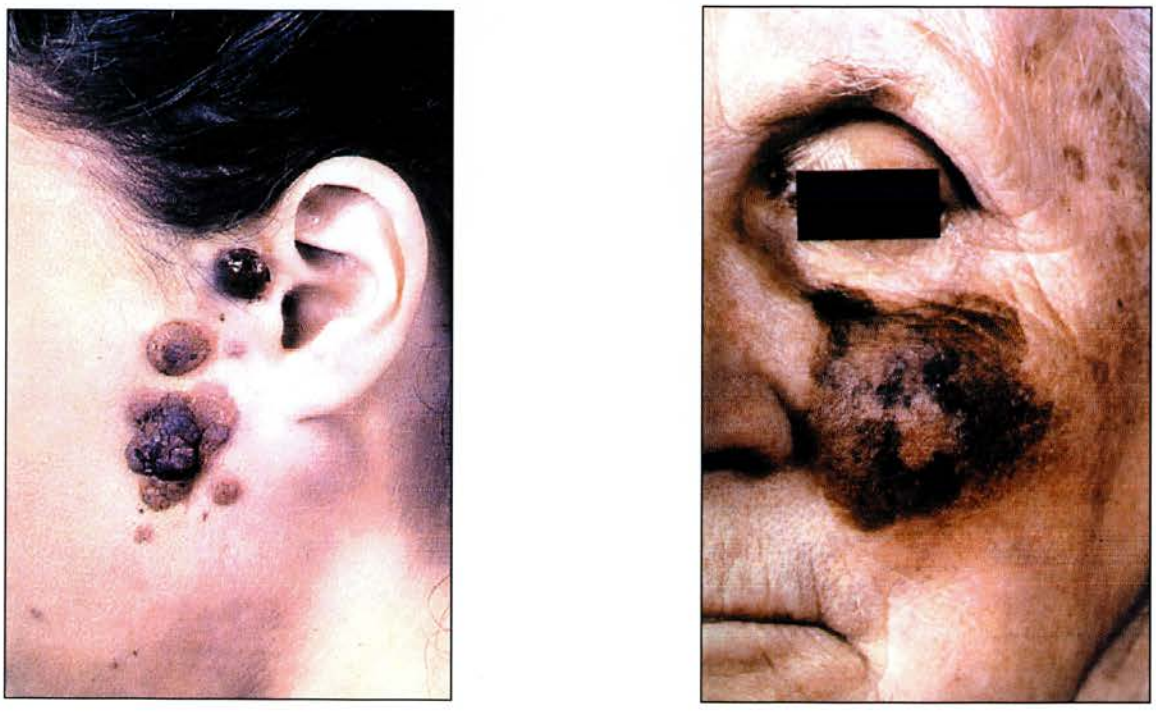


Figure 1.28.Colour photographs of malignant melanoma in text by Gracianski and Boulle (1952).

Photography has enable the more widespread illustration of skin problems, and still images (obtained as photographs) can be used to enable diagnosis at a distance, or telemedicine. The merging of the photographic process (particularly utilising digital technology) with computers and telecommunication have become possible at the close of the twentieth century, and it is of relevance that Fox-Talbot's discovery of the modern photographic process has been commemorated in a recent postage stamp (figure 1.29):

Figure 1.29.Stamp issued during 1999 to commemorate the contribution of Fox-Talbot towards the technical development of photography.

1.4 History of Photography

Early dermatological illustrations were often by artists, but this may have introduced artistic interpretations which were not always realistic. It was only with the introduction of photography, that realism became possible in medical illustration.

The effects of light upon organic and inorganic matter have been known since early human times, but the alchemists of the early Renaissance were the real

founders of photographic chemistry. Fabricus, in the 16th Century, was aware of the effect of light upon silver chloride but did not apply his knowledge to the production of images (Clarke, 1990). In 1802, a joint paper by Humphrey Davy and Thomas Wedgwood described "an account of a method of copying painting upon glass and making profiles by the agency of light on silver" (Young, 1995). Thomas Wedgwood was the third son of the famous potter Josiah Wedgwood and, although Thomas Wedgwood was able to make profiles of objects, he was unable to fix these images. In France, in 1826, the first photographic image, called a holograph, was made by Niepce. Louis Daguerre, born in 1787, formed a partnership with Niepce, but worked alone, after Niepce's death in 1833, to introduce daguerreotypes - single pictures which could not be used to make further copies.

William Henry Fox-Talbot (1800-1877) is regarded as the founder of modern photography (Young, 1995). Fox-Talbot, associated with Lacock Abbey, Wiltshire (figure 1.30), was the only son of William Talbot and had interests in mathematics, light, chemistry, botany, philosophy, astronomy and archaeology.

Figure 1.30.Lacock Abbey, Wiltshire. Family home of Fox-Talbot.

Fox-Talbot went to Trinity College, Cambridge and later, whilst on holiday in Italy, in 1833 wrote "how charming it would be if it were possible to cause these natural images to imprint themselves durably and remain fixed upon the paper". In 1834, on return from his continental tour, he was determined to test his theories with experiments. Writing in 1835 "in the photogenic or sciagraphic process, if the paper is transparent, the first drawing may serve as an object, to produce a second drawing, in which the light and shadows would be reversed".

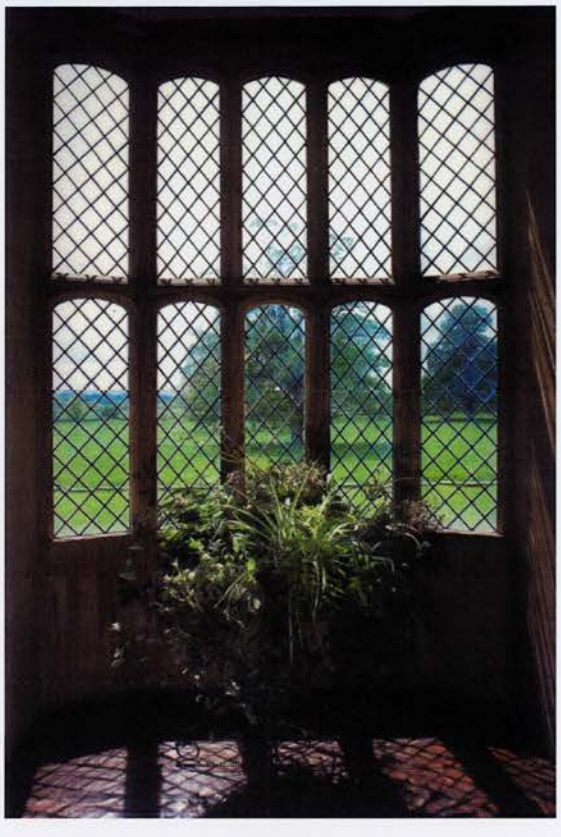


Figure 1.31.Oriel Window in the South Gallery,
Lacock Abbey, Wiltshire, 1835.

Combining his knowledge of chemistry and optics, Fox-Talbot in August, 1835, made some photographic images of the small central oriel window in the south gallery at Lacock Abbey (figure 1.31.), and this is the earliest known example of the photographic negative (figure 1.32). Fox-Talbot called his new images calotypes.

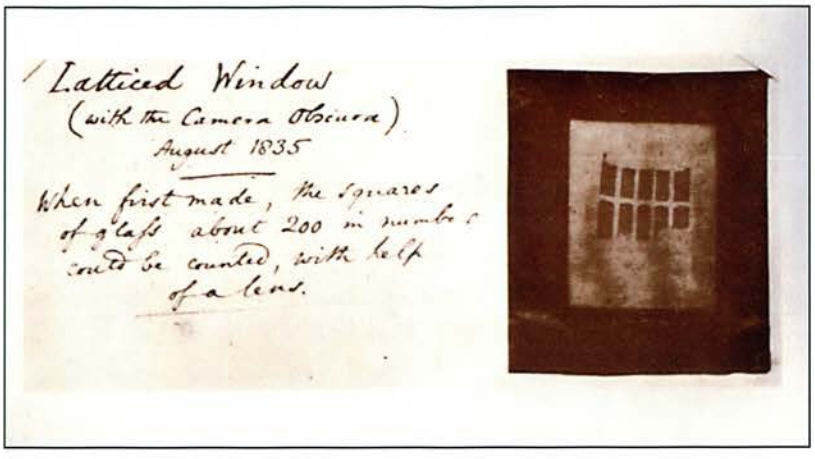


Figure 1.32.Photograph of The Oriel Window, circa. 1835, by Fox-Talbot

Whereas Daguerre described the plate method of image reproduction, Fox-Talbot was able to fix the photographic results, thereby enabling permanent records and modern photography. Although daguerreotypes initially had advantages over calotypes, particularly with more intricate detail of reproduction, calotypes were cheaper and simpler to produce. Fox-Talbot's calotype, the basis of the modern photograph, enabled faster exposure times (increasing its practical use) and had the advantage of enabling many copies to be made from the original negative. In Scotland, Adamson and Hill formed a partnership which enabled the production of over two thousand calotypes, early masterpieces of photography. Wet plates were introduced by Frederick Scott Archer in 1851, and dry plates were used by Roland Maddox, a physician and amateur photographer, in 1871. Dry plates were to revolutionise photography, enabling a significant reduction in equipment bulk, facilitated predominately by fewer chemicals being necessary for the development of images. George Eastman in 1885, and Hannibal Goodwin, invented the modern film, which was produced by Eastman in 1889, the year that an early Kodak camera was commercially introduced in America. A celluloid base was substituted for the glass, previously used for plates and the first Kodachrome film was introduced in 1914, although not marketed until some years later.

The camera obscura (early described by Leonardo da Vinci) was a method of producing images but the early cameras, capable of photographic reproduction, were simple boxes. Early lenses were primitive, but by the end of the 19th Century the basic box camera was available for more widespread photography, with a film roll rather than earlier plates (figure 1.33). Although celluloid was introduced in 1869, its first use in photography was in 1889 by the Eastman Company. The Brownie camera was first mass produced commercially in 1900.

Figure 1.33 A selection of box cameras in private collection, South Ronaldsay, Orkney. Canon Ixus Camera. Kodachrome 100 ASA film.

Although a European invention, photography developed rapidly in America, but German design introduced such well known names as Leica and Zeiss (White,1995a,b). Large number of different cameras followed, but then the development of the camera shutter in the focal plane initiated the development of the single-lens reflex (SLR) camera with its potential for 35mm photography, the basis of most modern photography (figure 1.34):

Figure 1.34 Olympus OM2 SLR camera with Tamron 80-300mm lens.

Some landmarks in the history of photography are summarised below (table 3):

Table 3.
Photographic history.

1837	The first daguerreotype
1841	Fox-Talbot introduces the calotype
1846	Zeiss establishes lens factory
1878	Introduction of gelatine dry plates
1884	Introduction of flexible negative film by Eastman
1900	Kodak produces first Brownie cameras
1924	Introduction of Leica camera
1942	Introduction of Kodacolour negative film

1.5 History of Medical Photography

Photography has been used in medicine since the mid 19th Century and possibly one of the earliest examples of a medical photograph was taken by the Edinburgh photographers, Hill and Adamson, sometime between 1843 and 1847. The photograph (figure 1.35), a calotype (after Fox-Talbot) was probably taken at the instigation of Dr James Inglis, of Halifax, a medical graduate of Edinburgh University.

Figure 1.35 Unknown woman with goitre. Calotype by Hill and Adamson, in collection of Scottish National Portrait Gallery, Edinburgh.

In 1862, Duchenne published an article with photographic illustrations - black and white wet plate images taken with a large format camera. In America, Dr John Draper (1811-1882), born in England, was considered to be one of the founders of American photography. During the American Civil War, photographs were also used record injuries (for war pensions) as well as to record medical and surgical problems (Burns, 1979a,b,c). From this time there were many examples of good quality photographs (daguerreotype) of Civil War wounds and a number of photographic examples of facial injuries were described by Rogers and Rhode (1995). In Britain, photographs were used during the Boer War to portray events that could be seen by the public who were then kept up to date with war progress.

In other parts of the world, black and white photography was used to record images up to and after the First World War, although colour photography was being used by World War II. Wallace (1985) described the history of clinical photography in plastic surgery, particularly with descriptions of World War II injuries.

In medicine, development in cameras and films have improved the quality of photographs, which can be used either educationally or for medical records. In France, in the latter part of the 19th Century, hospital-base clinical photography was more common, but in Britain (apart from some isolated examples) medical photography awaited the introduction of the National Health Service in 1948 (Williams, 1982; Cardew, 1992). Today, many hospitals (including Lancaster) have medical photography or medical illustration departments which can provide excellent quality medical illustrations for patient records or educational material for lectures.

The modern photographic process enables pictures of high quality resolution, giving the accurate reproduction of detail from objects imaged. Dermatological photography plays an important role in the recording and monitoring of patients' skin conditions (Slue et al, 1994). As well as for photographic records of dermatological problems, photographs can be used to help in the management of certain patients, for instance following unstable moles or dysplastic naevi (Dusel et al, 1990). Wilcox and Grimwood (1995) described the benefits of assessment of photographic 35mm images in a comparative study. Quality of photographs is important, and an example of a clinical photograph which could be used to facilitate diagnosis through telemedicine is shown below (figure 1.36):

Figure 1.36. Squamous cell carcinoma on ear.
Nikon FM2 camera, Nikon 105mm lens, Kodachrome 100 ASA film.

1.6 Science, Art and Photography

Medicine is an art as well as science, both also involved in photography. The Enlightenment was an era of great change in Europe, when knowledge and understanding grew, together with the power of reason over superstitution. Light grew in influence over darkness, with enhanced contrast between these extremes (Baxandall, 1995). Shadow perception, or edge visualisation / interpretation is a fundamental aspect of visual art - recognised early by Leonardo da Vinci, and later fully exploited by Rembrandt. In photography, this border between light and darkness is critical in forming the final image. John Locke (1694), an empiricist, helped how we perceive 3-dimensional objects from 2-dimensional visual stimuli, to be expanded later by the Scottish philosopher, David Hulme. Also from Edinburgh, Sir David Brewster, (1781 - 1868) a founder member of the British Association for the Advancement of Science and a Principal at Edinburgh University, was a friend of Fox-Talbot. Philosopher and scientist, he wrote "the power of bringing the remotest objects within the very grasp of the observer, and a swelling into gigantic magnitude in the almost invisible bodies of the material world" (Light from the Darkroom, 1995). He was describing optics and light, and at this time in Edinburgh there were eminent and innovative people promoting science, philosophy and the arts. Brewster kept in close communication with Fox-Talbot, the latter believing that the copying of works of art, and the distribution of reproductions in order to spread the knowledge of art, could be an important use of photography.

Towards the end of the 19th Century, photographs became easier to produce and there was a significant increase in both the number of photographs and also photographers. In both America and Europe, photography grew in stature as an art form. Vernacular photographs were to record everyday life, but in science, industry, and the media, photography as art, became important, and different art forms evolved in photography (Galassi, 1998).

Photography has been used extensively by explorers, and the Edinburgh explorer John Thompson (1837-1921) indicated "it has always been my ambition to see photography take its proper place as a means of illustrating exploration". Born in Edinburgh, he attended the Edinburgh School of Arts, at a time when there was a flourishing scientific community in Edinburgh, and was a contemporary of David Livingstone (Ovenden, 1997). The majority of Thompson's photographs used a

wet-collodion process, but he was able to produce photographs with exquisite detail. Although technically difficult to produce, especially considering the size of the equipment at the time together with long exposure developing times, these pictures would compare favourably (although black and white) with modern photographs, either conventional or digital. Later, the photographer Frank Hurley achieved an extensive historical photographic record of Shackleton's Antarctic expedition (figure 1.37).

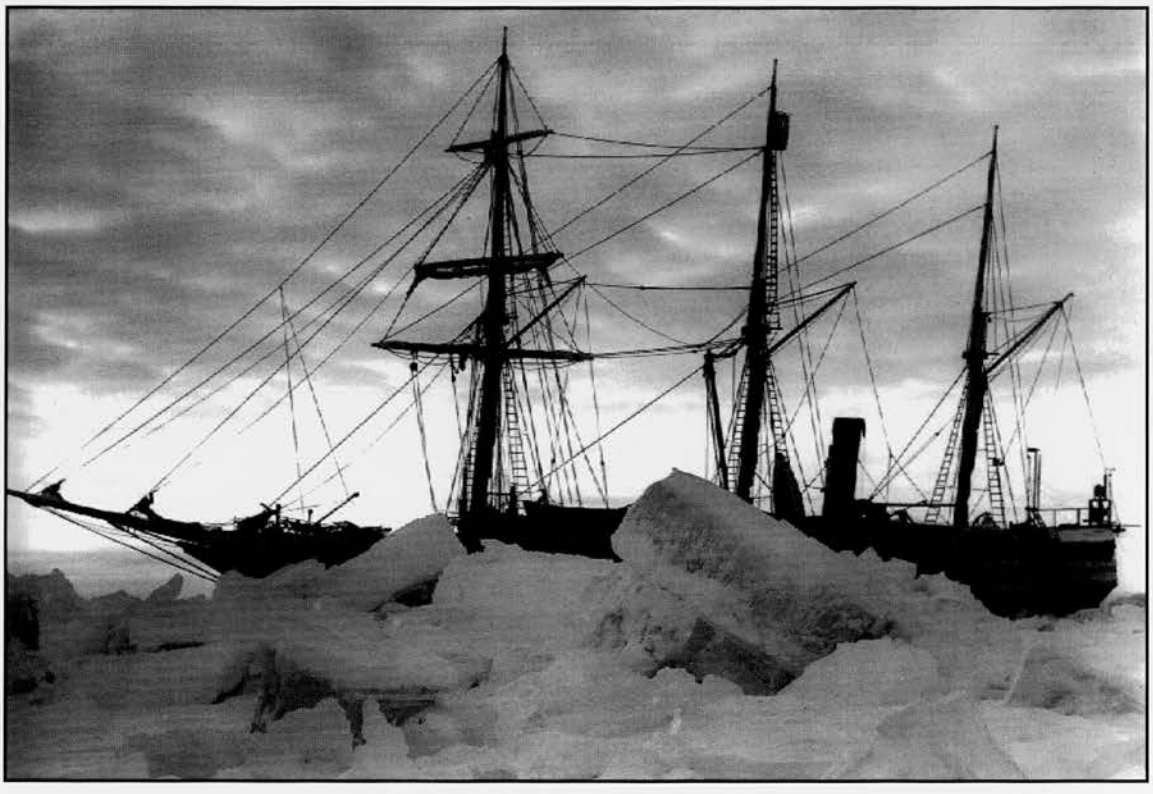


Figure 1.37. Endurance, at close of winter, August 1st, 1915. Photograph by Frank Hurley in The Endurance, by Caroline Alexander,1998, Bloomsbury, London.

John Barrow, was a founder of the Royal Geographical Society, which initiated many explorations throughout the world and a memorial to Barrow, above Ulverston (overlooking Morecambe Bay), is based on Eddystone lighthouse - illustrating the communicating power of light. Using light, a photograph (artistic or scientific), is, at its most basic, a likeness or facsimile of the original – whether the method uses daguerreotype, calotype, gelatin plate, silver print, polaroid, electronic scanner or digital image. But how do we interpret photographs, images from light? Figures 1.38 to 1.40 show trees in a winter landscape, but each of the trees is different - showing differing shapes and patterns.

Figure 1.38

Figures 1.38 - 1.40 Trees in a winter landscape. Canon EF camera, Canon 300mm lens, Kodachrome 64 film, shutter speed 1/60 - 1/125, aperture f5.6 to f11.

Figure 1.39

Figure 1.40

Colour can be as important as shape - recognised by philosophers - and Hegel wrote "shape, distance, boundaries, contours, in short all the spatial relations and differences of objects appearing in space, are produced in painting only by colour (Riley, 1995). A photograph is an illusion, and not true reality (Cadova, 1997). In

the assessment of photographs, we can take lessons from art (Form and Reading, 1997). When works of art, for example paintings, are examined certain rules apply in respect of perspective, angle of vision, tone range, colour range and the planes of the picture. In art, the term representation is used to indicate the reforming of the appearance of an object or scene into a conceptual image by the artist. Similarly, in photography, representation of an object occurs by the photographer. However, a photographic image of an object is never exactly the same as the original object. This is because there is inevetibably some alteration of the image, however subtle, by the camera, film or processing (or with digital images by the computer). Also, when viewing the image, it is likely that the observer doesn't have exactly the same viewpoint as the person who had viewed the object in the first place. Furthermore, no two individuals will view an object or scene in the same way, having different degrees of colour vision and perception of colour and space - recognised in art, but not always in science.

Traditionally, photography has used films which enable light from objects to be converted into images by the chemical alteration of silver particles in the film. The image formed from grains, which appear within the film, are the equivalent of artistic stippling or brush strokes used by the artist. Early photography influenced Impressionist painting, and much later the photographer Cartier-Bresson took everyday photography to a high art form (Times, 1999). Most still photography today is still in a 35mm film medium, but more recently digital photography is possible.

1.7 History of Digital Photography

Digital photography is a relatively recent phenomenon, but there are now a large number of digital cameras. Digital cameras have lenses and shutters which operate in much the same way as in conventional cameras. The difference

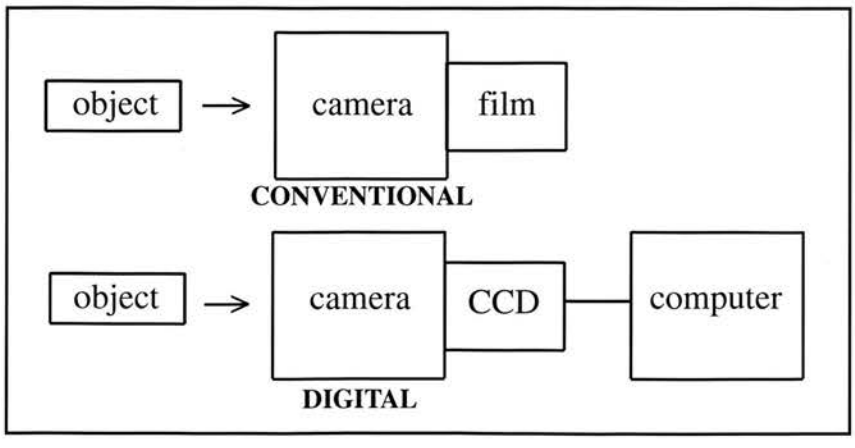


Figure 1.41. Comparison between conventional and digital cameras

between a conventional camera and a digital camera is primarily in the way that the images are recorded and stored. The film, which is present in a conventional camera (colour or black and white), is replaced in a digital camera with an electronic optical sensor called a charge-coupled device (CCD) (figure 1.41). In a conventional camera, the operation of the shutter allows the photosensitive film to be exposed to light, whereas in a digital camera, light passes onto the CCD surface where it is converted to digital information which is stored in the camera memory. The surface of the CCD contains a grid of light sensitive spots or pixels which record the quantity of light as a charge. The pixels, or picture element, are the computer equivalent of silver grains present in a standard photographic film. In a colour camera, pixels are grouped together in clusters, and filters are used to enable colour reproduction of images. Most computer software handles 24-bit colour or 256 levels of red, blue and green, which gives a range of 16.7 million possible colours.

The digital information is processed by a computer, and most modern computers can process data (with appropriate software) to enable picture reproduction on the computer screen. If necessary, images can be printed out using either an inkjet printer (having the advantage of low cost) or a dye sublimation printer (having the advantage of greater quality and resolution but with more cost). The latest generation of inkjet printers can give prints of comparible quality, and durability, to conventional photographic prints. This process involves chemical pigments, rather than inks, which adhere to paper sufaces rather than penetrate the paper. Here there are similarities with art - with oil paintings having greater varieties of colours, together with more clarity, than watercolours.

The picture quality in a digital photograph will be dependent upon the number of pixels in the digital camera and also the true likeness of brightness and colour in the image. Image quality will also depend upon the lens focusing and object illumination (as in conventional photography). The resolution of the image is dependant on the camera lens and its optical qualities, but the number of pixels will also determine the image resolution. Cameras with greater numbers of pixels will have better resolution and a standard 35mm conventional photographic image is approximately equal to 18 million pixels, this quality now achievable in digital photography.

Digital cameras in a high resolution range have often about a million or more pixels, whereas more expensive professional digital cameras may have over 5 million pixels of resolution. The Kodak DCS (digital camera system) was

introduced in 1991, and based on the Nikon F3 body is capable of high resolution, but not as good as the best conventional camera.

Digital cameras have a large number of uses including in the home, and at work by, for example, architects. Museums and art galleries can also use digital cameras effectively to form databases, and computer software can manipulate the images. In medicine, digital cameras can have an advantage over conventional equipment when used for clinical photography, by the significantly increased speed of picture formation. The image can be used as a record, either stored in the computer (disk, CD or tape,) or printed as with a conventional photographic print.

The Kodak DCS camera has been described as being suitable for clinical photography (Brown 1994). Sasson, Schiff & Stiller (1994) suggested digital cameras were capable of producing photographic images of acceptable quality for dermatological applications. Perednia, Gaines & Butruille (1995) compared digital photographs with conventional 35mm photographs, and described a similar diagnostic accuracy by both methods when images were used to assess dermatological diagnoses.

But, are there differences between digital and conventional cameras which may be important when the cameras are used clinically on patients? Are digital cameras as easy to use as conventional, and are the results likely to be good with digital as with conventional cameras? It is useful to compare the ability of different cameras to photograph everyday objects.

A wall plaque, on Willian's house in Sedbergh, was selected as a subject to compare the photographic results from different cameras. Five different cameras

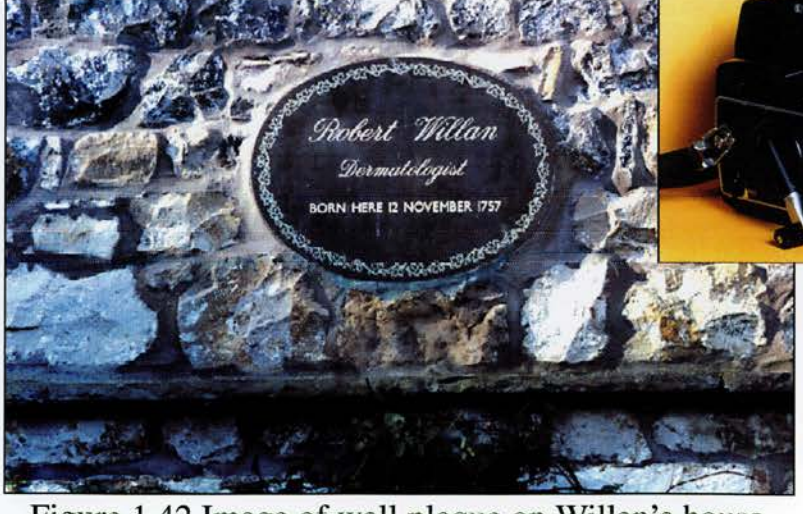


Figure 1.42.Image of wall plaque on Willan's house, taken with medium format conventional camera.

Medium format camera used for Fig.1.42

were used to take images of the same wall plaque - a medium format conventional camera, a 35mm conventional camera (Nikon F1), a high resolution digital camera (Kodak DC420), a lower resolution digital camera (Kodak DC40) and a Polaroid camera. Willan's plaque was photographed using the different cameras at the same distance from the subject, using similar lighting conditions, at the same time of day. The images (figures 1.42-1.46) are shown below:

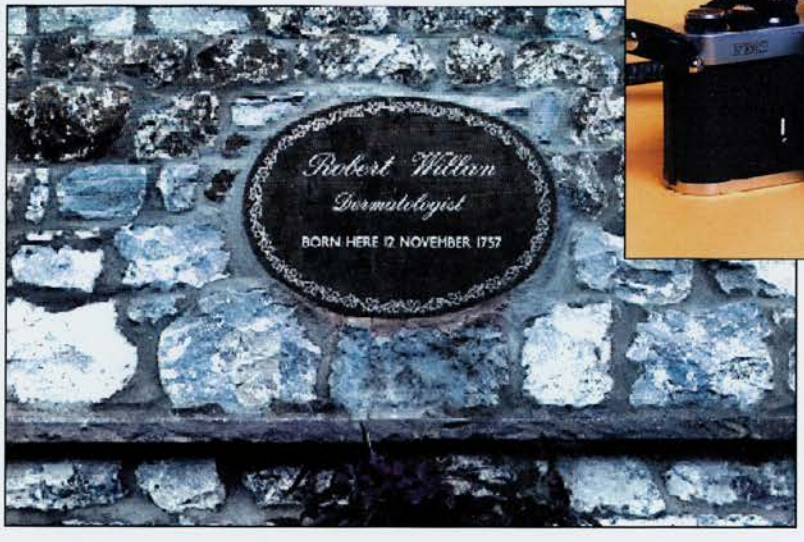


Figure 1.43. Image of wall plaque on Willan's house, taken with 35mm conventional camera (Nikon FM2).

Nikon FM2 SLR camera, with Nikon 105mm lens used for Fig.1.43.

Figure 1.44.Image of wall plaque on Willan's house, taken with high resolution digital camera (Kodak DC420).

Kodak DC420 camera, enabling high resolution digital photography, used for Fig. 1.44.

Kodak DC40 digital camera, adapted for clinical use to photograph skin tumours, used for Fig.1.45.

Figure 1.45.Image of wall plaque on Willan's house, taken with low resolution digital camera (Kodak DC40).

Polaroid camera used for Fig.1.46

Figure 1.46.Image of wall plaque on Willan's house, taken with Polaroid camera.

The clearest image of the wall plaque is taken with the medium format conventional camera, but close behind in quality is the 35mm SLR camera, followed by the high resolution digital camera - whereas the low resolution digital and Polaroid cameras gave less clear images.

More expensive digital cameras, with higher resolutions, can produce images virtually as good as those obtained with 35mm conventional cameras. Today, many digital cameras and computers are available for digital photography. A suitable digital camera and computer system for dermatology images is shown on figure 1.47:

Figure. 1.47. Kodak DC 420 digital camera and 200MhZ computer system suitable for digital imaging.

A digital photograph, showing a basal cell carcinoma on the nose, is shown in Figure 1.48:

Figure 1.48.Digital photograph of basal cell carcinoma on nose, taken with Kodak DCS420 camera with Nikon 105mm lens.

Another example of a digital image, magnified 200 times, is shown on Figure 1.49:

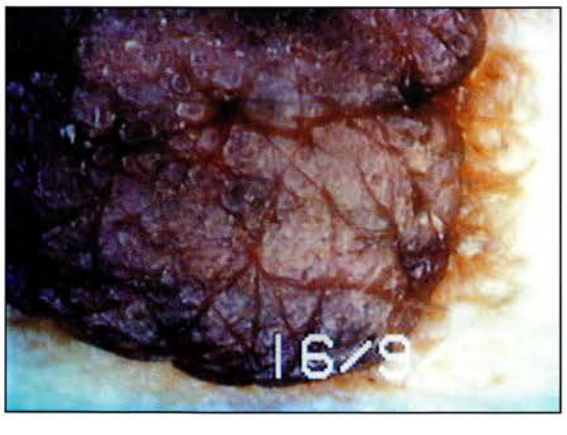


Figure 1.49.Digital image of benign mole at magnification 200X. Digital image taken with Scopeman instrument.

Both the above digital photographs could be used in telemedicine, the transmitted images being used to assess dermatological problems at a distance.

1.8 Telemedicine

Communication over distances has only become possible with technological developments. Now, communication is part of everyday life, but in the past, speech and social development had enabled man to communicate in groups. An ancient form of communication, still visible today, was in the form of stone circles which would be visible to many people from a more distant viewpoint, and an example would be the Ring of Brodgar, Orkney, (figure 1.50). With the

Figure 1.50 Ring of Brodgar, Orkney.Cannon Ixus camera.
Kodachchrome 100 ASA film.

development of methods of communications such as post, telephone, and more recently radio and digital, faster communication suitable for medicine has become possible.

Telemedicine has been defined as medicine practice at a distance (Sosa-Iudicissa, Wootton & Ferrer-Roca, 1998) but usually means the use of modern technology, including computers and communication equipment, to deliver health care at a distance (Preston, Brown & Hartley, 1992) Another definition of telemedicine is the use of telecommunications and information technology to provide healthcare services to persons at a distance from the provider (Grigsby & Sanders, 1998). A simple definition of telemedicine is the provision or support of health care by telecommunication technology (Dodd, 1999).

Telemedicine usually involves telecommunication equipment, and another definition is any system of medical care in which a doctor and patient are at a

different location. Also telemedicine can be defined as remote, telemetric healthcare; using information and communication systems to give patients, and healthcare workers, access to relevant information sources wherever they are located (Curry, Norris & Parry, 1997). Telemedicine has also been described as the provision of health care using a telecommunications link where the patient is at a different location from advising professionals (Maclean, Brebner & Norman, 1997). Wootton (1996, 1998a) defined telemedicine as rapid access to shared and remote medical expertise by means of telecommunication and information technologies, no matter where the patient or the relevant information is located. According to the World Health Organisation, "telemedicine is the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interest of advancing the health of individuals and their communities". Telemedicine, and more specifically teledermatology, was the subject of a recent comprehensive review by Eedy and Wootton (2001).

Having a Greek origin, *tele* indicates distance and broadly telemedicine could include any medical activity at a distance. Using the simplest telemedicine definition, methods of data transmission would include post, telegraph, telephone, radio, television, wireless or facimile. However, in a more accurate telemedicine definition (particularly for this thesis), telemedicine involving computers and communication equipment would usually involve digital data transfer methods such as land or surface lines (using digital telephone networks), but also may include satellite links and either stationary or mobile telephones with modem computer links. Computer communication and the rapid expansion of the Internet has also provided a route for telemedicine (Bittorf, Krejci-Papa & Diepgen, 1995). America and Scandinavia, but also a number of other European, Australian and Asian countries, have embraced telemedicine. In Third World countries there may be a significant underprovision of healthcare delivery, and in certain places, for example Malaysia and South Africa, there are initiatives to promote telemedicine - since without the facility, much of the population may continue to face inadequate healthcare. In Britain, telemedicine could improve access to healthcare for people living remote places such as on the west coast of Scotland, and a review of Scottish telemedicine was described by Maclean, Brebner & Norman (1995). Preston, Brown & Hartley (1992) described the use of telemedicine to improve health care in remote communities, also described by Oakley et al (1997), and Allen (1999) described the use of telemedicine to areas

where medical services may be difficult to organise - also described by Norton et al (1997)

In ships, planes and spacecraft, telemedicine can improve medical care at a distance (Mark, 1991). Telemedicine also has military uses, with data being transmitted to a remote, and safe, medical support unit which can be either field or hospital-based. An initiative in the British Army has pioneered telemedicine in Bosnia and used a satellite phone (Ritchie, 1998), but later Internet links (Vassallo, Bookson & Kilbey, 1998). The Department of Defence, in the United States of America, has initiated a large programme to develop telemedicine for peace-time use to enable efficient deployment of troops, and this has commenced in Europe. Telemedicine can save time and money by preventing costly and lengthy transfer of military personnel requiring medical assessment. Outside human medicine, telemedicine techniques have been used in veterinary medicine and also the same technology has many other scientific applications, where there is a need for remote data assessment, both in science and industry, but also in art. The earliest use of a picture for telemedicine was perhaps by the German Renaissance painter Dürer (1471 - 1528), who in the 15th Century used a painting of himself to remotely ask for medical advice concerning abdominal pain (Calne, 1996). In our own area, Morecambe Bay (figure 1.51), a number of medical specialities could pursue telemedicine including dermatology, radiology, cardiology, intensive care, accident and emergency/trauma medicine, psychiatry, pathology, oncology and ophthalmology. Initiatives have occurred in cardiology, psychiatry and dermatology. Telemedicine has a number of applications in medicine and, after radiology, dermatology is the commonest speciality involved in the subject (Ferrer-Roca, 1998). Dermatology is a speciality that has readily adopted telemedicine (Warburton, 1991), and telemedicine has enormous health care opportunities for altering the delivery of health care.

Figure 1.51 Waves in Morecambe Bay. Canon EF camera, Canon 80-200mm lens, Kodachrome film ASA 64, shutter speed 1/60, aperture f11.

A recent government white paper, and more recently a publication from the NHS Executive (Information for Health, 1998) have indicated a government initiative to "modernise" the NHS and introduce new technology. The electronic patient record (EPR) and telemedicine are planned to "revolutionise" healthcare delivery. "The challenge for the NHS is to harness the information revolution and use it to benefit patients" (Prime Minister Tony Blair).

The NHS Direct initiative has been introduced with manned phone lines (Robinson, 1999) to enable interaction between patients and nurses, to offer primary care advice. This has been successfully piloted and planned that it will be spread more widely, with decision making by nurses being helped by computer programs and on-line services have also been developed. The concept is designed to reduce pressures on emergency services, and to enable first hand advice to be given to patients. However, one concern with telephone consultations is that telephone skills may not be uniform and a study by Foster, Jessopp & Dale (1999) showed that the confidence with which advice may be given reflects whether or not there was prior medical knowledge of patients, although this study examined general practitioners and not nurses (Foster, Jessop & Dale, 1999). Recently, a British Medical Journal editorial (Florin & Rosen, 1999) expressed concern over the introduction of services, such as NHS Direct, without proper planning.

Telemedicine is now being used in primary or community care, secondary or hospital care, and tertiary care and can help in the management of patients and enhance education and training. Some possible benefits of telemedicine are summarised below (table 4):

Table 4
Telemedicine benefits.

Patient	Primary Care	Hospital or secondary care
Reduced time inconvenience	Improved access to specialist skills	More effective use of specialist time
Consultation in a more familiar environment	Greater choice of providers of service	Reduced waiting times
More control over case management	Reduced travelling time for patients	Less patient dissatisfaction
Reduced waiting time for specialist appointment	Improved training	More resources for other hospital services

Wallace, Wyatt & Taylor (1998) summarised some of the advantages of telemedicine including: equitable access to care in remote settings;provision of home care for elderly patients; facilitating cost effective care, reducing clinician travel and unnecessary patient transfers; together with new models of care and educational benefits.

A number of different methods (table 5) can be used to achieve telemedicine and these range from use of voice in simple telephone conversations through to computer manipulation involving telerobotic surgery. Telemedicine can be 'live' or real-time as in video-conferencing, or store-and-forward as with still photographic imaging. Some telemedicine methods are summarised below with an indication whether or not the technique achieves true telemedicine or not.

Table 5
Telemedicine methods.

Mode	Example	True Telemedicine
Voice alone	Conventional telephone discussion	No
Image alone	Viewing of photographs	No
Data alone	E mail	No
Voice & data	Computer integration	Possible
Voice & non-realtime data	Store & foreward computer system	Yes
Voice & realtime data	Telemonitoring	Possible
Voice & data & realtime image	Videoconferencing or virtual consultation	Yes
Data & computer manipulation	Telerobotics or computer assisted surgery through virtual reality	Yes

For the purpose of this thesis, true telemedicine may be defined as "the practice of medicine involving the use of computers together with telecommunication equipment to enable patient management, at a distance, facilitated by data transfer." Taking this definition, the viewing of conventional photographs would not be true telemedicine, but video-conferencing with the transmission of digital images would be.

Video-conferencing involves the use of computer equipment to facilitate real-time interaction between individuals, with moving images and voice facilitating data exchange. Although video-conferencing can be utilised for store-and-forward systems, when data is recorded and played back at a future date, generally the technology is used for real-time interaction. Video-conferencing can be time consuming for individuals involved, and may be more useful for certain medical problems. For example, in psychiatry, patients can be interviewed at a distance and assessed for treatment. In dermatology, video-conferencing has been assessed for patient management. Sneiderman & Hood (1991) described video assessment inferior to the examination of photographic images of the skin, and there is evidence that video-conferencing may be less cost-effective than still image enabled telemedicine (Loane et al, 1998). Oakley et al (1997) described (using either 128 or 384 band width) video-conferencing achieving a diagnostic accuracy of 75% and, in a study by Lowitt et al (1998), there was a concordance of 80% between face to face and video assessment of skin lesions. The method was more suitable for tumours than rashes, but there was a wide variation in agreement between dermatologists with regard to diagnoses, as low as 50% concordance for some skin conditions. A multi-centre teledermatology trial has examined video-conferencing in four centres-two in Northern Ireland (Belfast and Craigavon), one in Manchester and one in Hamilton, New Zealand (Loane, Bloomer & Corbett, 1998; Loane et al, 1998). This study found that two thirds of patients were diagnosed correctly through video-conferencing, when compared with face-to-face diagnosis in a clinic, also there being similar success with management plans for patients.Later, Wootton et al (2000) found that real-time teledermatology, using video-conferencing, was not cost effective when compared with conventional dermatological management. Also, a systematic review of 32 telemedicine studies (Mair & Whitten, 2000), involving video-conferencing, identified a number of limitations within some the research methods. In particular, some studies had only a few subjects, and some of the questionnaires may have needed refinement.

Video-conferencing can effectively be used for educational purposes and also help facilitate discussion between people, instead of travelling to meetings. When video phones (particularly mobile) become more commonplace, video-conferencing would become much more an everyday possibility, facilitating real-time patient interviews and assessment.
There are a number of advantages and disadvantages with video-conferencing and these are summarised below (table 6):

Table 6
Video-conferencing advantages and disadvantages.

Advantages	Disadvantages
Interactive in real-time	Image quality can be inferior to still image transmission
Can be useful for patient history	Can be time consuming
Can demonstrate problems readily and useful in education	Can be sometimes difficult to set up if a few people are involved
May be more useful for rashes than tumours	Sometimes complex equipment fails
Can be appropriate for psychiatric consultations	More high quality equipment can be expensive

When large numbers of images are being assessed, for example in helping with dermatological waiting lists (particularly when dealing with skin tumours), a store-and-forward system can be a more efficient method of practising telemedicine. Eedy and Wootton (2001) also suggested the more widespread use, in dermatology, of store-and-forward systems rather than video-conferencing. This is the approach used in the present work, and photographs may have a possible use for diagnosing certain skin problems. Photographs can be conventional or digital, but conventional photography can have certain advantages over digital photography as shown on Table 7:

Table 7
Conventional photography, advantages and disadvantages.

Advantages	Disadvantages
Well established method	Cost of multiple images
Moderate cost and ease of use of the equipment	May be a long turnaround time for finished images
High resolution images relatively easy to produce	Storage of multiple images may be bulky
Consistency of image, particularly in experienced hands	Prints or slides may deteriorate with time

However, digital photography, can have a number of advantages as well as disadvantages, shown on Table 8:

Table 8
Digital photography, advantages and disadvantages.

Advantages	Disadvantages
Quick turnaround time for viewing of finished images	Currently, costs of digital cameras and computers still mean digital photography can be more expensive than conventional photography
Possibility of image manipulation, e.g. image enhancement, alteration of colour and contrast	Image quality and resolution of images may still be inferior to conventional photographic images
Possibility of image transfer suitable for telemedicine	Equipment possible more prone to break down than conventional equipment

Useful for both undergraduate and postgraduate teaching, telemedicine can help with practice-based medical education. There are numerous opportunities, with the formation of primary care health groups, to use telemedicine both to help manage patients and also to improve medical education, one possibility being through websites - through the Internet or NHS intranet. A study by Michaelis and D'Souza (1999) assessed teledermatology achieved via a hospital intranet system. This was considered to be a service which could reduce waiting lists and costs, although consultants viewed it as an adjunct to their normal clinical work and not a substitution for face-to-face consultations.

In any analysis of telemedicine, it is important to assess the costs when compared with conventional delivery of healthcare, and this was examined by Loane (1999). videoconferencing found to benefit the patient rather than more benefit in terms of healthcare expenditure. However, cost-benefits have not adequately been examined for still imaging, and in particular its application to dermatology. Futhermore, more research is necessary to assess patient satisfaction with telemedicine (Mair & Whitten, 2000).

A number of advantages and disadvantages of telemedicine are summarised on Table 9:

Table 9
Telemedicine advantages and disadvantages.

Advantages	Disadvantages
More equitable access to healthcare	Possibility of incomplete or inaccurate information for interpretation
Facilitation of more cost effective healthcare	Possibility of increased use of clinical time, particularly with videoconferencing
Possibility of new models of care or linking doctors with centres of excellence	Possibility of increased secondary waiting lists
May facilitate continued professional development	Equipment costs
May facilitate early diagnosis and treatment of problems, leading to enhanced clinical outcome	Possibility of equipment failure

Because telemedicine is a new development, the medicolegal aspects of telemedicine are still being assessed. However, there are a number of lawyers interested in telemedicine, and the problem is being addressed in various countries, including America and Australia. In Britain, the academic aspects of the law, in respect to telemedicine, are being addressed at the University of Cardiff, Wales and elsewhere (Stanbrey, 1999). Brahams (1997), described some medicolegal implications of telemedicine, also discussed by Lanske (1996), and also confidentiality is an issue (Andreae, 1996). The medicolegal aspects of teledermatology were recently reviewed by Eedy & Wootton (2001). As well as the advantages and disadvantages of telemedicine shown above (table 9), there are a number of particular problems which may arise in any telemedicine system. A number of these problems, with potential solutions, are shown on Table 10:

Table 10 Telemedicine problems and solutions.

Problem	Patient Impact	Solution
Image fault	Potential wrong diagnosis	Review in clinic
Wrong image	Potential wrong diagnosis	Accurate identification of data
Wrong action	Wrong treatment and result	Review patient in clinic
Lost image	No diagnosis or treatment	Data protection
Leak of information	Loss of confidentiality	Equipment and software security
Delay in treatment	Morbidity or potential mortality	Rapid data interpretation
Reaction to treatment	Morbidity or potential mortality	Identification of appropriate treatment
Inadequate reassurance	Increased anxiety	Improved communication to patient
Lost opportunity for discussion of patients problems	Increased anxiety	Improved communication to patient

A telemedicine health guidance note (Stanbrey 1999) indicates that ultimately, telemedicine is a vehicle for the delivery of health care. People have the same rights to quality care as they do with conventional delivery. The legal duty of the doctors involved in teleconsulting is the same as for those offering advice/opinion by telephones, fax, e-mail or face-to-face consultation. Any unforeseen medicolegal implications of telemedicine will be revealed by litigation as it arises. However, basically the same rules apply to telemedicine as with conventional medicine. Precautions and safeguards are necessary, both for the patient and the doctor.

It has been suggested that a telemedicine strategy should be based on a number of principles (Dodd, 1999) and a working party met to discuss a co-ordinated U.K. approach to dermatology, relevant in view of some services being already set up independently without necessarily proper coordination (Wallace, 1999). This supported the view that telemedicine should meet clinical needs and not be technologically driven; use only appropriate technology; be developed in the context of national clinical priorities and information, management and technology (IMT) strategy; support the integration of health care services; and develop from research projects to planned clinical services. Also, there is a view that any teledermatology development should not usurp, or impeed, local dermatological services.

1.9 Development of Telemedicine as a Speciality

Telemedicine, as a new branch of medicine, has been transformed into an established speciality of medicine. Annual meetings and forums allow the interchange of ideas and, more recently, the recognition of telemedicine as a developing field by The Royal College of Physicians and The British Association of Dermatologists will help the future development of the subject. The emergence of telemedicine as a subspeciality was highlighted by the establishment of a chair in telemedicine at Belfast and this has initiated regular telemedicine forum meetings with the Royal Society of Medicine. Recently, the United Kingdom Telemedicine Association (UKTA) has been formed and this will link with the Institute of Health Services Management (IHSM) telemedicine reference group. The purpose of the telemedicine and telecare reference group, is to help the introduction of effective telemedicine and telecare applications in the NHS.

The purpose of the United Kingdom Telemedicine Association will be to:

encourage improvement in health care delivery through the application of telecommunications technology; promote the professional and ethical standards of the caring professions; promote the development of telemedicine policy and standards, encourage in the adoption of uniform world wide standards and practice; promote telemedicine research and education; ensure public and official confidence in and recognition of the value of telemedicine to world health and the individual; recognise the need for protection of intellectual property rights by the telemedicine industry; interact with telemedicine associations in other countries; and encourage the examination of telemedicine information and services, create opportunities for members to meet and share their knowledge, experiences and ideas, organise formal national and international occasions for that purpose and where appropriate take united action in their common interests.

The IHSM group have a number of activities including: the promotion of discussion and debate across the whole health care community by organising and contributing to national and regional conferences and seminars; undertaking more detailed studies of the potential benefits of telemedicine and telecare in particular localities; contributing to the debate on the future configuration of hospitals and health services; and facilitating a Telemedicine and Telecare Reference Group for the four Departments of Health in England, Scotland, Wales and Northern Ireland - this group including clinicians, managers, academics, technicians and suppliers.

Telemedicine needs appropriate planning, but with this there can be benefits to the NHS and patients. National and local coordination is necessary to enable the proper development of telemedicine, now seen as a speciality within medicine. In addition to development of telemedicine, training issues need to be addressed, (Blignault and Kennedy, 1999), and this is one aspect of the subject which has been addressed by a working party which met on behalf of the British Association of Dermatologists in 1999.

1.10 Telemedicine Standards and Evaluation

There should be standards with regard to image quality and consistency. Protocols should be established for the routine use of telemedicine in clinical practice. However, despite the introduction of telemedicine in a number of areas, there have been few rigorous trials in the United Kingdom (Wootton, 1998b) and only been a few assessments of teledermatology (Perednia, Gaines & Butruille 1995). It is important that appropriate evaluation is undertaken before there is the routine use of telemedicine in clinical practice. In the North West of England, Manchester has been involved in a multi-centre U.K. trial and a pilot study, again using video-conferencing, has been undertaken in Scotland. Also a pilot study in Lancaster is described in an NHS estates document (Telemedicine and Telecare Project, 1998).

The Cochrane Library has been attempting to effectively assess telemedicine - to establish that there was no difference in the outcomes of care delivered remotely via telemedicine compared with face-to-face care, no differences in the economic consequences of care delivered remotely via telemedicine compared with face-to-face care, no difference to patients/clients in the acceptability of care delivered remotely via telemedicine compared with face-to-face care, no difference in professional practice during the delivery of care delivered remotely via telemedicine compared with face-to-face care, and no difference in the transfer skills between clinicians, and in care delivered remotely via telemedicine compared with face-to-face care (Curry, Norris & Parry, 1998).

Ideally, the same standards and quality of care for patients should be offered through telemedicine as in face-to-face clinical situations. But are clinical outcomes the same in telemedicine as in conventional clinics? What are the economic benefits of telemedicine, and is telemedicine acceptable to patients, doctors and health managers? There are a number of questions to be asked of telemedicine, but also significant opportunities which could be gained from different studies.

1.11 Telemedicine Questions and Opportunities

Table 11 indicates a number of possible opportunities of telemedicine:

Table 11
Telemedicine opportunities.

Primary care initiatives
Hospital initiatives
Community and home care
Healthcare re-organisation
Enhanced patient responsibility

Primary care initiatives may include the management of different medical problems in a primary care environment rather than hospital environment. Hospital initiatives include use of telemedicine for dermatological management. Community and home care uses of telemedicine include the management of more people at home with different medical problems. Healthcare reorganisation may result from telemedicine, if it can change the practice of an aspect of medicine. Also, enhanced patient responsibilty can be a result of telemedicine. However, before the acceptance of telemedicine as a clinical method, there may be some questions and these may include the following (table 12):

Table 12
Telemedicine questions.

Can it work?
What are the advantages or disadvantages?
Are certain methods of practices in telemedicine better than others?
What are the patient benefits of telemedicine?
What are the cost benefits of telemedicine?

For the method to be adopted routinely in clinical practice, it is important to establish which telemedicine method might be more suitable for achieving dermatological diagnosis and managment.

1.12 Thesis Objectives

It was planned to initiate a teledermatology service in Morecambe Bay. However, before achieving this objective, the effectiveness of both conventional and digital still photographic imaging was examined in the management of dermatological problems, particularly skin tumours. Store-and-forward telemedicine was to be studied, rather than the application of video-conferencing to dermatology. The thesis objectives can be summarised as follows:

a) Could conventional photographic images be used to achieve a dermatological diagnosis?

b) Could conventional photographic images of skin lesions, taken in a clinic situation, be used for patient management?

c) Would a method of dermatological patient management, using photography, be acceptable to patients?

d) Would a method of dermatological diagnosis using photography be acceptable to general practitioners?

e) Could a simple, low cost, system using digital images achieve telemedicine?

f) Could a simple, low cost, system using digital images achieve telemedicine via the Internet?

g) Could digital teledermatology be achieved using an ISDN-based system, thereby facilitating practical teledermatology?

A description of equipment used, and patients studied, follows in Chapter 2.

CHAPTER 2

MATERIALS AND METHODS

2.1 Cameras

2.1.1 Conventional Cameras

A variety of cameras were used in the different studies. In studies 1 to 6, conventional photographic equipment was used, and most of the work was undertaken using a Nikon FM2 camera. However, in the digital studies (7-9), the digital camera Kodak DC40 (lower resolution) and Kodak DCS420 (high resolution) cameras were used, in association with computer equipment. In the conventional studies, the camera used was a Nikon FM2 instrument, shutter speed B to 1/4000secs, with 105mm micro Nikkor f2.8 lens. The films used in these studies was Kodak Gold, ASA100, and development utilised a C41 process (undertaken locally in Lancaster), and the final photographic prints were made on Kodak professional paper.

A Nikon FM2 camera used in the conventional photographic studies is shown below (figure 2.1):

Figure 2.1. Nikon FM2 camera used in conventional photographic studies (studies 1 - 6).

2.1.2 Digital Cameras

In the digital studies, 2 cameras were used - Kodak DC40 and Kodak DCS420. Each of these 2 cameras have different technical specifications as follows:

Kodak DC 40 - 24-bit colour digital camera with image resolution of 756 X 504 pixels. A 4MB memory can store up to 48 standard or 99 compressed digital images. The lens was a 42mm, f2.8, instrument with Tiffin close up stack. The Kodak DC40, modified for use in the studies, with provision of a fixed distance between the camera and the skin, is shown below (figure 2.2):

Figure 2.2. Kodak DC40 camera used in digital photographic studies (studies 7 - 9).

Kodak DCS 420 - Based on the Nikon N90 camera body, the camera has a picture resolution of 1012 X 1524 pixels and utilises 36-bit colour. A Nikon 105mm lens was used with the camera (figure 2.3):

Figure 2.3. Kodak DC420 camera. A high resolution digital camera (used in study 9).

The camera chip in these cameras produces a smaller image area than standard 35mm film, however, the field of view of the camera was equivalent to utilising a lens with 2.6 times focal length of the lens in use - i.e. equivalent to 273mm. The software used was Adobe Photoshop and Figure 2.4 shows one of the computers used in the digital studies:

Figure 2.4. 200Mhz computer suitable for image processing and teledermatology.

2.2 Image Acquisition Areas

Environments were standardised to make lighting as equal and uniform as possible, in different areas in which skin lesions were photographed, either with conventional or digital cameras. Skin lesions were photographed using natural light plus the automatic camera flash, and no colour background was utilised for any of the photographs. In the clinic environment, some images were taken by a professional medical photographer, but when clinical photographs were taken by different doctors in the clinics, as near as possible, rooms were chosen with similar lighting conditions. When photographic images were taken of skin lesions in the Medical Illustration Department, Royal Lancaster Infirmary, this was undertaken by a professional medical photographer in the photographic studio.

2.3 Patients

The subjects were patients attending the dermatology department - at either Lancaster, Kendal or Barrow. Consent was obtained from all patients, and each study had the support of the local ethical committee.

Participating patients had photographs taken of their skin lesions (invariably skin tumours). A measurement rule was placed alongside each skin lesion being photographed (conventional studies), and this was incorporated into the photograph in the conventional photographic studies to enable measurement of the tumour size. In addition, in the conventional photographic studies, a unique

identification number (invariably the patient record number) was also photographed alongside the skin lesion to ensure later identification of the photograph with the patients' records to enable analysis. Images were photographed with a magnification of 1:2, but there was a final print magnification of 1.5:1. In digital studies, when images were taken of skin lesions using the Kodak DC40 camera, an adjustable arm (with an attached pointer) was used to provide a fixed distance between the camera and the skin tumour. A professional medical photographer took the photographs in conventional studies 1 to 6, and medical staff undertook most of the image acquisition in digital studies 7, 8 and 9.

After imaging of the skin lesions, either conventional or digital, the skin tumour was then removed when appropriate and histology obtained to enable comparison of the histological diagnosis with the diagnosis by image assessment. The histological diagnosis was usually used as the gold standard for assessment of diagnostic accuracy. However in the digital studies, comparison was also made between the image analysis and that diagnosis obtained in a face-to-face consultation.

2.4 Image Assessment

Conventional photographic prints were viewed in rooms with natural lighting, and digital images were viewed in natural ambient daylight. Digital images were assessed on a 21 inch Liyama computer screen - high resolution images at a magnification of 10X, and low resolution images at a magnification of 4X life size.

It is recognised that inter-observer variation occurs between doctors when assessing skin lesions (Perednia, Gaines & Rossum, 1992), and most of the image assessment was by one person (PVH). However, image assessment was also undertaken by another doctor in the digital study (study 9). Inter-observer variation was not assessed in this study since the great majority of assessments were made by a single individual. In all of the studies, no patients with a tumor or rash had been seen clinically before by the doctor assessing the images of the patients skin problems.

2.5 Analysis of Results

The diagnosis from photographic assessment was compared with the diagnosis obtained in a face-to-face situation when appropriate, However, whenever possible, the diagnosis by photographic assessment or telemedicine, was compared with the diagnosis by a histological assessment (always the same pathologists assessed the histology, having had no previous clinical knowledge of the patients), recognising that there may sometimes be diagnostic variations between individual pathologists (Blewitt, 1995). The diagnostic accuracy was expressed as a percentage in each of the relevant studies. In Study 2, patient assessment of photographic imaging was assessed by using a visual analogue scale. Study 5 assessed patient views on imaging (patients being involved in Study 4) and Study 6 assessed general practitioners views on photographic imaging as a means of dermatological management. In Studies 4 and 9, in addition to the diagnostic accuracy being assessed, the use of image analyis to enable the differentiation of benign and malignant skin lesions was assessed, by comparing the teledermatologist diagnosis with the histological diagnosis. Furthermore, in both Studies 4 and 9, the ability of photographic imaging to enable appropriate skin management was also assessed. Statistical analysis used the confidence interval analysis and was assessed using the Arvus Quick Step Biomedical program (Addison Wesley, Longman Ltd). ROC analysis (Hanley & McNeil, 1982; Metz, 1989) was undertaken to determine the certainty of decisions, in the analysis of images during the last digital study - ROC analysis being recognised as a standard statistical method for telemedicine evaluations (Ferrer-Roca, 1998)

It is acknowledged that a comparison of image assessment with face-to-face consultation clinics would have formed a more realistic comparison of the teledermatology methods with routine clinical work. However, although most assessments compared image-led diagnosis with that obtained by histological assessment (a more accurate or true diagnosis), in Studies 7, 8 and 9 there were comparisons of the clinical diagnosis with that obtained by image assessment.

CHAPTER 3

PILOT STUDIES ASSESSING DERMATOLOGICAL DIAGNOSIS BY CONVENTIONAL PHOTOGRAPHY

3.1 Introduction

Photography has been previously examined as a method of assessing dermatological problems, with promising results (De Barker, 1996), also described in an Australian study (Del Mar & Green, 1995). Other workers have studied video-conferencing as a telemedicine method (Gilmour et al, 1998), but the present work has studied still photography for assessing dermatological patients, particularly those with skin tumours. Although later studies (7-9) examined digital photography, with the possibility of image transmission, the earlier studies (1-6) used conventional photography for assessing patients.

Pilot studies were designed to examine dermatological diagnosis using conventional photography. The studies were to test the effectiveness of conventional photographs being used to enable dermatological diagnosis. The first study, Conventional Pilot Study A (study1), examined images taken of skin lesions when people attended clinics in the Lancaster dermatology department, whereas the third study, Conventional Pilot Study B (study 3), used image acquisition in the Medical Illustration Department, Royal Lancaster Infirmary. Study 2 looked at patient acceptance of dermatological diagnosis through skin images.

3.2 Study 1. Conventional Pilot Study A

3.2.1 Introduction

Although the ultimate objective was to establish a teledermatology service in Morecambe Bay, it was felt necessary to examine whether or not still photographic imaging could effectivly be used to enable patient management. Before examining digital photography, conventional photography was used in the

first pilot studies. The first study was designed simply to test whether or not conventional photographs could be used to enable dermatological diagnosis.

3.2.2 Methods

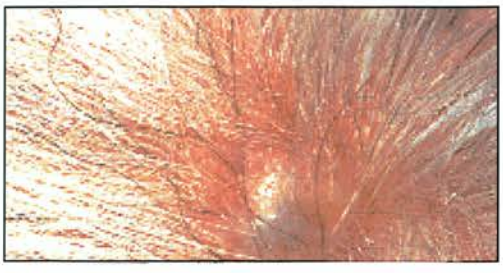
Prior to attendance at the Lancaster dermatology department for skin surgery, the patients skin lesion was photographed by a medical photographer, using a Nikon FM2 camera (figure 2.1). Subsequently, the skin tumour was removed surgically, and submitted for histological examination. The conventional photograph was later available for viewing by the dermatologist (PVH, who had not seen or operated upon the patient) for an assessment of the diagnosis. The diagnosis, by image assessment, was later compared with the histological diagnosis (available after skin tumour removal) to indicate accuracy of image assessment.

Patients were selected randomly by taking all those who attended for skin surgery in consecutive, monthly, surgical sessions. The tumours were all in easily accessible sites, not obscured by clothing, hair, body contours.

3.2.3 Results

There were 38 photographs from 26 patients (14 males and 12 females, age range 12yrs to 76yrs, mean 53.4yrs), some patients having multiple skin tumours. The conventional photographic images are shown (figures 3.1 - 3.37), with the histological diagnosis indicated for each skin tumour:

Photographic images of skin tumours in conventional Pilot Study A. Study 1. Images standardised for all patients.



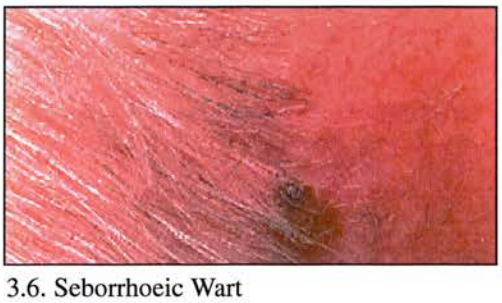
3.1. Sebaceous Cyst

3.2. Viral Wart

3.3. Dysplastic Naevus

3.4. Benign Freckle/Lentigo

3.5. Seborrhoeic Wart



3.6. Seborrhoeic Wart

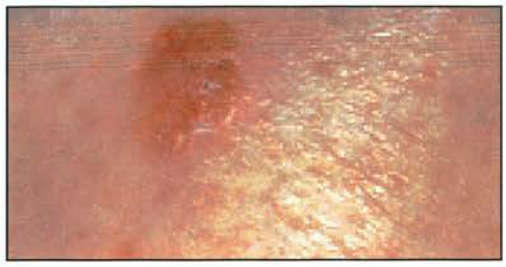
3.7. Seborrhoeic Wart

3.9. Seborrhoeic Wart

3.8. Benign Melanocytic Naevus

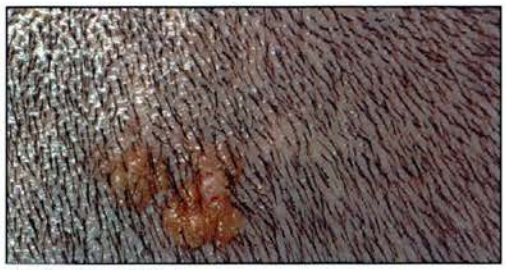
Photographic images of skin tumours in conventional Pilot Study A. Study 1.

3.10. Seborrhoeic Wart



3.11. Basal Cell Carcinoma

3.12. Squamous Cell Carcinoma

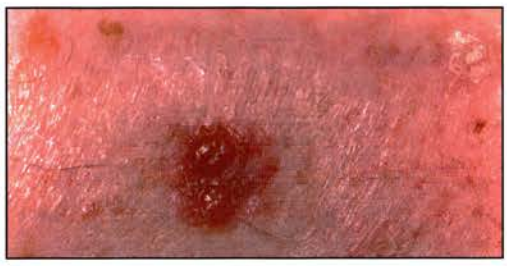


3.13. Viral Wart

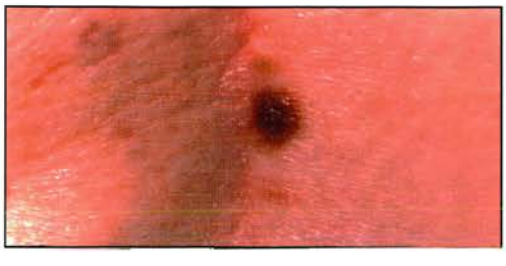
3.14. Actinic Keratosis

3.15. Squamous Cell Carcinoma

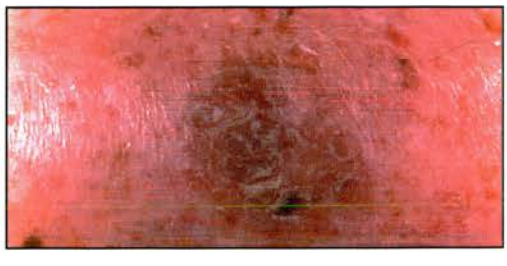
3.16. Benign Melanocytic Naevus



3.17. Basal Cell Carcinoma



3.18. Benign Melanocytic Naevus



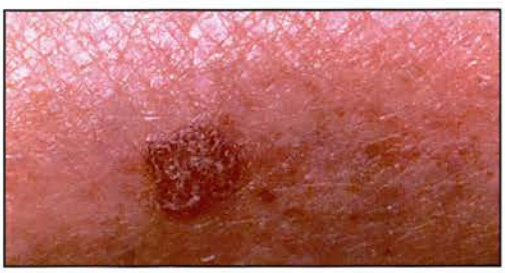
3.19. Bowen's Disease

Photographic images of skin tumours in conventional Pilot Study A. Study 1.

3.20. Actinic Keratosis

3.21. Sebaceous Cyst

3.22. Squamous Papilloma



3.23. Actinic Keratosis

3.24. Squamous Cell Carcinoma

3.25. Squamous Cell Carcinoma

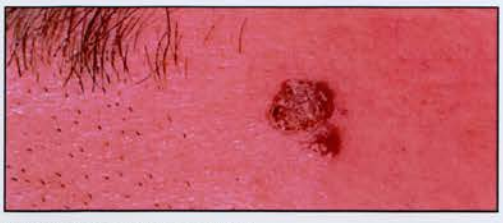
3.26. Dermatofibroma

3.27. Viral Wart

3.28. Benign Melanocytic Naevus

3.29. Benign Melanocytic Naevus

Photographic images of skin tumours in conventional Pilot Study A. Study 1.



3.30. Seborrhoeic Wart

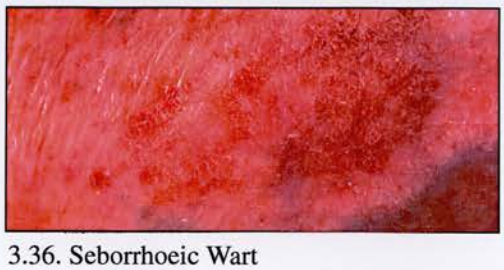
3.31. Benign Melanocytic Naevus

3.32. Non - specific

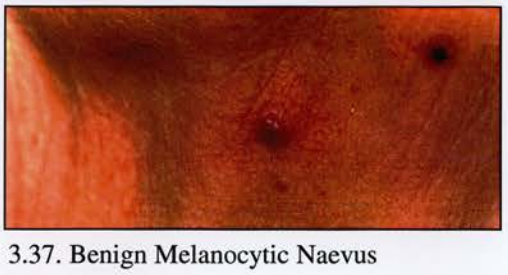
3.33. Sebacous Cyst

3.34. Squamous Cell Carcinoma

3.35. Squamous Cell Carcinoma



3.36. Seborrhoeic Wart



3.37. Benign Melanocytic Naevus

3.38. Actinic keratosis

The diagnostic accuracy in this study was found to be 82% (95% confidence interval 66% to 92%.) Table 13 indicates whether or not there was agreement between the photographic and the histological diagnosis:

Table 13
Photographic diagnosis compared with histological diagnosis.

Image	Diagnosis from Photograph	Diagnosis by Histology	Agree/disagree
3.1	Sebaceous Cyst	Sebaceous Cyst	Agree
3.2	Viral Wart	Viral Wart	Agree
3.3	Dysplastic Naevus	Dysplastic Naevus	Agree
3.4	Benign Freckle/Lentigo	Benign Freckle/Lentigo	Agree
3.5	Seborrhoeic Wart	Seborrhoeic Wart	Agree
3.6	Seborrhoeic Wart	Seborrhoeic Wart	Agree
3.7	Seborrhoeic Wart	Seborrhoeic Wart	Agree
3.8	Benign Melanocytic Naevus	Benign Melanocytic Naevus	Agree
3.9	Seborrhoeic Wart	Seborrhoeic Wart	Agree
3.10	Seborrhoeic Wart	Seborrhoeic Wart	Agree
3.11	Bowen's Disease	Basal Cell Carcinoma	Disagree
3.12	Basal Cell Carcinoma	Squamous Cell Carcinoma	Disagree
3.13	Viral Wart	Viral Wart	Agree
3.14	Actinic Keratosis	Actinic Keratosis	Agree
3.15	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Agree
3.16	Benign Melanocytic Naevus	Benign Melanocytic Naevus	Agree
3.17	Basal Cell Carcinoma	Basal Cell Carcinoma	Agree
3.18	Dysplastic Naevus	Benign Melanocytic Naevus	Disagree
3.19	Bowen's Disease	Bowen's Disease	Agree
3.20	Bowen's Disease	Actinic Keratosis	Disagree
3.21	Sebaceous Cyst	Sebaceous Cyst	Agree
3.22	Squamous Papilloma	Squamous Papilloma	Agree
3.23	Squamous Cell Carcinoma	Actinic Keratosis	Disagree
3.24	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Agree
3.25	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Agree
3.26	Dermatofibroma	Dermatofibroma	Agree
3.27	Viral Wart	Viral Wart	Agree
3.28	Benign Melanocytic Naevus	Benign Melanocytic Naevus	Agree
3.29	Benign Melanocytic Naevus	Benign Melanocytic Naevus	Agree
3.30	Irritated Seborrhoeic Wart	Irritated Seborrhoeic Wart	Agree
3.31	Benign Melanocytic Naevus	Benign Melanocytic Naevus	Agree
3.32	Non - specific	Non - specific	Agree
3.33	Sebaceous Cyst	Sebaceous Cyst	Agree
3.34	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Agree
3.35	Squamous Cell Carcinoma	Squamous Cell Carcinoma	Agree
3.36	Bowen's Disease	Seborrhoeic Wart	Disagree
3.37	Haemangioma	Benign Melanocytic Naevus	Disagree
3.38	Actinic Keratosis	Actinic Keratosis	Agree

There were 7 patients in whom there was disagreement between the diagnosis by photograph, and the histological diagnosis (images 3.11, 3.12, 3.18, 3.20, 3.23, 3.36, 3.37), but this did not adversely affect the clinical management of any of the patients. The different diagnostic groupings, with the number of patients having different diagnoses (by photographic or histological assessment) are shown on Table 14:

Table 14
Number of patients with different diagnoses, whether by photograph or histological assessment.

Photographic Diagnosis		Histological Diagnosis	
Non - specific	1	Non - specific	1
Sebaceous Cyst	3	Sebaceous Cyst	3
Viral Wart	3	Viral Wart	3
Seborrhoeic Wart	6	Seborrhoeic Wart	7
Benign Melanocytic Naevus	5	Benign Melanocytic Naevus	7
Benign Freckle	1	Benign Freckle	1
Squamous Papilloma	1	Squamous Papilloma	1
Dermatofibroma	1	Dermatofibroma	1
Haemangioma	1	Haemangioma	0
Actinic Keratosis	2	Actinic Keratosis	4
Basal Cell Carcinoma	2	Basal Cell Carcinoma	2
Bowen's Disease	4	Bowen's Disease	1
Squamous Cell Carcinoma	6	Squamous Cell Carcinoma	6
Dysplastic Naevus	2	Dysplastic Naevus	1
Total	38	Total	38

From Table 14, it can be seen that skin malignancies were diagnosed photographically in 14 patients, and histologically in 12 patients, an excess of 2 patients.

3.2.4 Discussion

The present study showed that, in an unselected group of dermatology patients, conventional photographs could be used for the diagnosis of skin tumours. Although a small series of patients, the diagnostic accuracy (82%) was found to be similar to that achievable in out-patient clinics, during face-to-face consultations (80%-85%-personal observations). It was important to confirm these findings, which would form the basis for later larger studies (studies 3 to 4). Also, before introducing photographic imaging as a method of patient management, and prior to assessment of digital imaging, it was important to assess patient views on skin assessment using photographs of skin lesions.

3.3 Study 2. Conventional Pilot Study B. Patient Views on Skin Assessment by Photographic Imaging

3.3.1 Introduction

After the initial pilot study (study 1), patient views were sought on whether skin assessment by photography would be acceptable or not, as a means of managing dermatological problems.

3.3.2 Methods

A hundred patients, attending dermatology clinics in Lancaster, were assessed using a 10cm visual analogue scale. The patients were not those being studied via photography, and had no previous experience of telemedicine, but were an unselected, consecutive group of patients attending clinics for face-to-face routine assessment of skin tumours in hospital clinics.

Patients were interviewed, and a verbal explanation of methods to be used in the imaging studies were given to patients. It was not specified whether the photographic assessment would be by conventional or digital photography. Patient's were asked to mark on a visual analogue scale, ranging from 0 (unsatisfactory) to 100 (completely satisfactory), a score of 80 or more being used to indicate a patient's satisfaction with skin assessment by photography. The visual analogue scale was chosen as a method of assessment for convenient use in a clinic situation.

3.3.3 Results

94 out of the 100 patients completing the visual analogue scale (94%) were satisfied that skin assessment by photography could be an alternative to clinic (face-to-face) assessment (based on a score of greater than 80%). No patient expressed significant dissatisfaction about the possibility of skin assessment by photography.

3.3.4 Discussion

The assessment of patient's views, whether or not skin management by photography would be acceptable as an alternative to clinic visits, showed that a photographic method was viewed as favourable in a high percentage of patients (94%). A criticism of the study could be that patients had a prior concept of skin imaging before the interview, but this was later addressed in Study 9 and also during the later clinical service. Furthermore, it was possible that the interviewer could have introduced bias by themselves being involved in studies on the photographic assessment of skin problems. However, despite these limitations, the present study did suggest that patients would view favourably photography as a method of skin assessment and management. Study 1 had examined the diagnostic accuracy of photographs and were used to assess skin tumours. However, the photographer had taken images in hospital clinic, and the next study assessed whether a hospital-based medical illustration department could be used for patient assessment.

3.4 Study 3. Conventional Pilot Study C. Assessment of medical photography as image acquisition centre for photographic assessment of skin tumours.

3.4.1 Introduction

So far, still (conventional) photographic imaging has been investigated for the identification of skin tumours in patients attending hospital-based dermatology clinics (study 1). Later, patient views were sought on the suitability of photographic assessment being used for skin tumour identification and management (study 2). In Study 1, dermatological diagnosis obtained by image assessment was compared with the histological diagnosis after skin tumour

removal. Histological diagnosis was used as a gold standard, rather than face-to-face skin examination, since it might be a more appropriate standard with which to judge telemedicine in dermatology (Lowitt et al, 1998).

However, remote diagnosis had not yet been examined, and the next study was to use conventional photographic images acquired at a remote site (the Lancaster medical illustration department,) by a professional medical photographer. The images would be examined by a dermatologist in a seperate place, thereby facilitating a store-and-forward telemedicine method. This was to be a low-tech approach, using a simple definition of telemedicine as the practice of medicine at a distance.

3.4.2 Methods

Over a three month period, patients attending the hospital dermatology clinics in Lancaster, were invited to participate in the study. Patients with skin tumours, prior to their attendance at the dermatology department, were invited to attend the medical illustration department in Lancaster. Conventional photographic images were taken of skin lesions, using a Nikon FM2 camera (figure 2.1), and the subsequent photographic images were available for analysis by the dermatologist, the photographs obtained by a professional medical photographer.

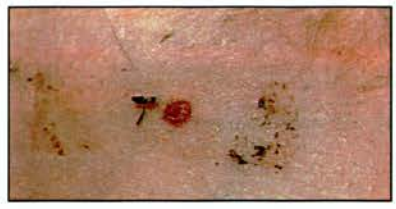
Subsequently, the patient attended the dermatology clinic and was seen by a dermatologist (PVH), who had not previously seen the patient. The dermatologist, assessed the diagnosis and organised the appropriate treatment for the skin lesion, which usually necessitated removal and subsequent histological assessment.

3.4.3 Results

There were 141 patients, 58 males and 83 females, age range 2yrs-94yrs, mean 55.5yrs. The photographic images follow (for 129 patients in the study), with the histological diagnosis shown for each skin tumour (figures 3.39-3.167):

Photographic images of skin tumours in Conventional Pilot Study C. Study 3. Images standardised for each patient.

3.39. Actinic Keratosis



3.40. Pyogenic Granuloma

3.41 Benign Melanocytic Naevus

3.42. Benign Melanocytic Naevus

3.43. Benign Melanocytic Naevus

3.44. Benign Melanocytic Naevus

3.45. Squamous Cell Carcinoma

3.46. Basal Cell Carcinoma

3.47. Basal Cell Carcinoma

3.48 Actinic Keratosis

3.49. Actinic Keratosis

3.50. Basal Cell Carcinoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

3.51. Solar Elastosis

3.52. Benign Melanocytic Naevus

3.53. Actinic Keratosis

3.54 Basal Cell Carcinoma

3.55. Basal Cell Carcinoma

3.56. Syringocystadenoma Papilliferum

3.57.. Squamous Cell Carcinoma

3.58. Squamous Cell Carcinoma

3.59. Squamous Cell Carcinoma

3.60. Squamous Cell Carcinoma

3.61. Seborrhoeic Wart

3.62 Basal Cell Carcinoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

3.63. Benign Melanocytic Naevus

3.64. Benign Freckle/Lentigo

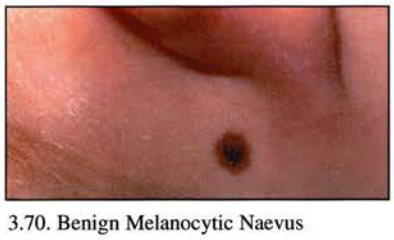
3.65. Adnexal Tumour

3.66. Benign Frekle/Lentigo

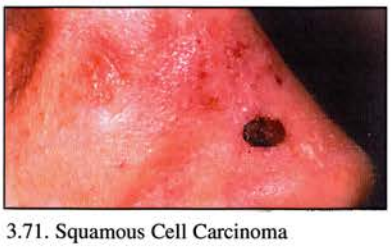
3.67. Benign Freckle/Lentigo

3.68. Benign Melanocytic Naevus

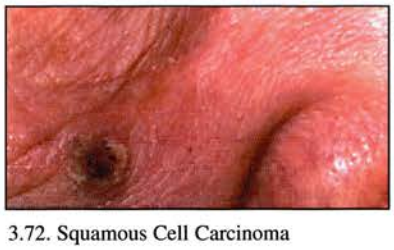
3.69. Basal Cell Carcinoma



3.70. Benign Melanocytic Naevus



3.71. Squamous Cell Carcinoma



3.72. Squamous Cell Carcinoma

3.73. Basal Cell Carcinoma

3.74. Angiokeratoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

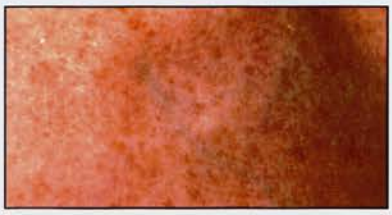
3.75. Seborrhoeic Wart

3.76. Seborrhoeic Wart

3.77. Basal Cell Carcinoma

3.78. Dermatofibroma

3.79. Seborrhoeic Wart



3.80. Freckle

3.81. Dysplastic Naevus

3.82. Benign Melanocytic Naevus

3.83. Non - specific

3.84. Benign Melanocytic Naevus

3.85. Benign Melanocytic Naevus

3.86. Seborrhoeic Wart

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

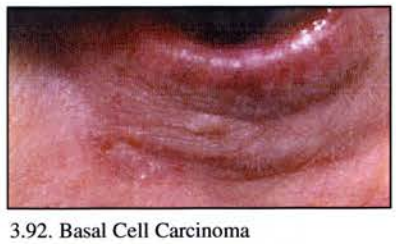
3.87. Benign Melanocytic Naevus

3.88. Benign Melanocytic Naevus

3.89. Basal Cell Carcinoma

3.90. Basal Cell Carcinoma

3.91. Basal Cell Carcinoma

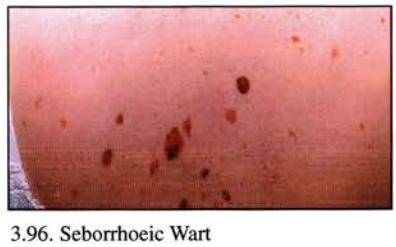


3.92. Basal Cell Carcinoma

3.93. Benign Melanocytic Naevus

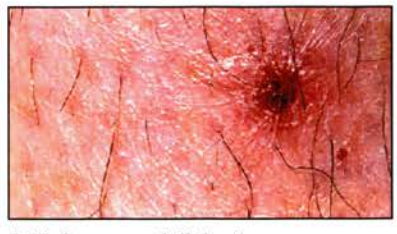
3.94. Basal Cell Carcinoma

3.95. Basal Cell Carcinoma



3.96. Seborrhoeic Wart

3.97. Dermatofibroma



3.98. Squamous Cell Carcinoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

3.99. Basal Cell Carcinoma

3.100. Squamous Cell Carcinoma

3.101. Benign Melanocytic Naevus

3.102. Benign Melanocytic Naevus

3.103. Non - specific

3.104. Basal Cell Carcinoma

3.105. Keratoacanthoma

3.106. Squamous Cell Carcinoma

3.107. Squamous Cell Carcinoma

3.108. Benign Melanocytic Naevus

3.109. Squamous Cell Carcinoma

3.110. Squamous Cell Carcinoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

3.111. Trichillemoma

3.112. Squamous Cell Carcinoma

3.113. Squamous Cell Carcinoma

3.114 Benign Melanocytic Naevus

3.115. Actinic Keratosis

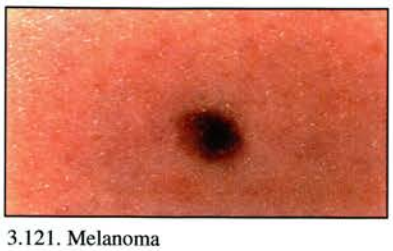
3.116. Actinic Keratosis

3.117. Squamous Cell Carcinoma

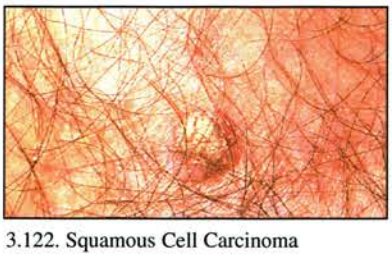
3.118.Basal Cell Carcinoma

3.119. Basal Cell Carcinoma

3.120. Sebaceous Cyst



3.121. Melanoma

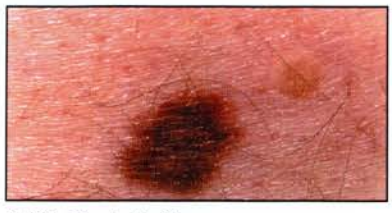


3.122. Squamous Cell Carcinoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

3.123. Squamous Cell Papilloma

3.124. Basal Cell Carcinoma



3.125. Dysplastic Naevus

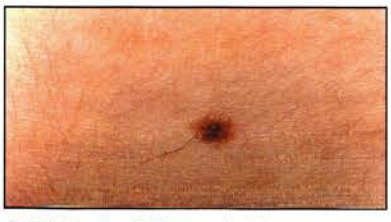
3.126. Actinic Keratosis

3.127. Non - specific

3.128 Squamous Cell Carcinoma

3.129. Benign Melanocytic Naevus

3.130. Squamous Cell Carcinoma



3.131. Benign Melanocytic Naevus

3.132. Basal Cell Carcinoma

3.133 Basal Cell Carcinoma

3.134 Basal Cell Carcinoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

3.135. Seborrhoeic Wart

3.136. Squamous Cell Carcinoma

3.137. Benign Melanocytic Naevus

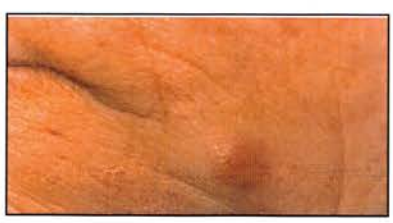
3.138. Pyogenic Granuloma

3.139. Seborrhoeic Wart

3.140. Squamous Cell Carcinoma

3.141. Benign Melanocytic Naevus

3.142. Seborrhoeic Wart



1.143. Benign Melanocytic Naevus

1.144. Benign Melanocytic Naevus

3.145. Seborrhoeic Wart

3.146. Benign Melanocytic Naevus

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

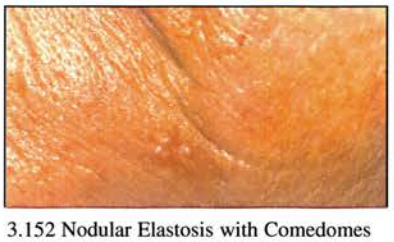
3.147. Benign Melanocytic Naevus

3.148. Sqamous Cell Carcinoma

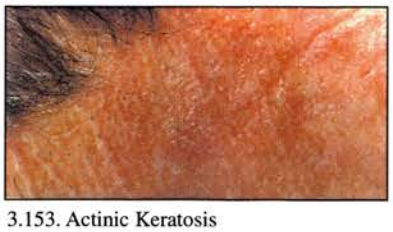
3.149 Angiokeratoma

3.150. Keratoacanthoma

3.151 Basal Cell Carcinoma



3.152 Nodular Elastosis with Comedomes



3.153. Actinic Keratosis

3.154. Seborrhoeic Wart

3.155. Benign Melanocytic Naevus

3.156. Squamous Cell Carcinoma

3.157. Benign Lentigo/Freckle

3.158. Squamous Cell Carcinoma

Photographic images of skin tumours in Conventional Pilot Study C. Study 3.

3.159. Benign Melanocytic Naevus

3.160. Non-specific

3.161. Seborrhoeic Wart

3.162. Lentigo Maligna

3.163. Squamous Cell Carcinoma

3.164. Benign Melanocytic Naevus

3.165. Dermatofibroma

3.166 Benign Melanocytic Naevus

3.167 Benign Melanocytic Naevus

The diagnosis obtained by examination of the conventional photographic images was compared with the diagnosis obtained by histology, and Table 15 shows whether or not there was agreement:

Table 15
Photographic diagnosis compared with histological diagnosis.

Image	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
3.39	Actinic keratosis	Actinic keratosis	Agree
3.40	Pyogenic granuloma	Pyogenic granuloma	Agree
3.41	Dysplastic naevus	Benign melanocytic naevus	Disagree
3.42	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.43	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.44	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.45	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.46	Basal cell carcinoma	Basal cell carcinoma	Agree
3.47	Basal cell carcinoma	Basal cell carcinoma	Agree
3.48	Squamous cell carcinoma	Actinic keratosis	Agree
3.49	Squamous cell carcinoma	Actinic keratosis	Agree
3.50	Basal cell carcinoma	Basal cell carcinoma	Agree
3.51	Actinic keratosis	Solar elastosis	Disagree
3.52	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.53	Squamous cell carcinoma	Actinic keratosis	Disagree
3.54	Basal cell carcinoma	Basal cell carcinoma	Agree
3.55	Basal cell carcinoma	Basal cell carcinoma	Agree
3.56	Squamous cell carcinoma	Syringocystadenoma papilliferum	Disagree
3.57	Basal cell carcinoma	Squamous cell carcinoma	Disagree

Table 15 Continued

Image	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
3.58	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.59	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.60	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.61	Seborrhoeic wart	Seborrhoeic wart	Agree
3.62	Bowen's disease	Basal cell carcinoma	Disagree
3.63	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.64	Dysplastic naevus	Benign lentigo / freckle	Disagree
3.65	Adnexal tumour	Adnexal tumour	Agree
3.66	Benign freckle	Benign lentigo	Agree
3.67	Benign melanocytic naevus	Benign freckle/lentigo	Disagree
3.68	Benign melanocytic naevus	Benign melanocytic naveus	Agree
3.69	Basal cell carinoma	Basal cell carcinoma	Agree
3.70	Benign melanocytic naevus	Benign melanocytic naveus	Agree
3.71	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.72	Basal cell carcinoma	Squamous cell carcinoma	Disagree
3.73	Squamous cell carcinoma	Basal cell carcinoma	Disagree
3.74	Angiokeratoma	Angiokeratoma	Agree
3.75	Seborrhoeic wart	Seborrhoeic wart	Agree
3.76	Basal cell carcinoma	Seborrhoeic wart	Disagree
3.77	Basal cell carcinoma	Basal cell carcinoma	Agree
3.78	Basal cell carcinoma	Dermatofibroma	Disagree
3.79	Seborrhoeic wart	Seborrhoeic wart	Agree
3.80	Benign freckle	Benign freckle	Agree
3.81	Dysplastic naevus	Dysplastic naevus	Agree

Table 15 Continued

Image	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
3.82	Seborrhoeic wart	Benign melanocytic naevus	Disagree
3.83	Squamous cell carcinoma	Non-specific	Disagree
3.84	Dysplastic naevus	Benign melanocytic naevus	Disagree
3.85	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.86	Seborrhoeic wart	Seborrhoeic wart	Agree
3.87	Seborrhoeic wart	Benign melanocytic naevus	Disagree
3.88	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.89	Basal cell carcinoma	Basal cell carcinoma	Agree
3.90	Basal cell carcinoma	Basal cell carcinoma	Agree
3.91	Basal cell carcinoma	Basal cell carcinoma	Agree
3.92	Basal cell carcinoma	Basal cell carcinoma	Agree
3.93	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.94	Basal cell carcinoma	Basal cell carcinoma	Agree
3.95	Basal cell carcinoma	Basal cell carcinoma	Agree
3.96	Benign melanocytic naevus	Seborrhoeic wart	Disagree
3.97	Dermatofibroma	Dermatofibroma	Agree
3.98	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.99	Squamous cell carcinoma	Basal cell carcinoma	Disagree
3.100	Basal cell carcinoma	Squamous cell carcinoma	Disagree
3.101	Benign melanocytic naevus	Benign melanocytic naveus	Agree
3.102	Benign melanocytic naevus	Benign melanocytic naveus	Agree

Table 15 Continued

Image	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
3.103	Squamous cell carcinoma	Non-specific	Disagree
3.104	Basal cell carcinoma	Basal cell carcinoma	Agree
3.105	Basal cell carcinoma	Keratoacanthoma	Disagree
3.106	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.107	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.108	Benign melanocytic naevus	Benign melanocytic naveus	Agree
3.109	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.110	Basal cell carcinoma	Squamous cell carcinoma	Disagree
3.111	Basal cell carcinoma	Trichillemoma	Disagree
3.112	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.113	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.114	Squamous cell carcinoma	Benign melanocytic naveus	Disagree
3.115	Squamous cell carcinoma	Actinic keratosis	Disagree
3.116	Actinic keratosis	Actinic keratosis	Agree
3.117	Basal cell carcinoma	Squamous cell carcinoma	Disagree
3.118	Squamous cell carcinoma	Basal cell carcinoma	Disagree
3.119	Basal cell carcinoma	Basal cell carcinoma	Agree
3.120	Benign melanocytic naevus	Sebaceous cyst	Disagree
3.121	Melanoma	Melanoma	Agree
3.122	Seborrhoeic wart	Squamous cell carcinoma	Disagree

Table 15 Continued

Image	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
3.123	Squamous papilloma	Squamous papilloma	Agree
3.124	Squamous cell carcinoma	Basal cell carcinoma	Disagree
3.125	Dysplastic naevus	Dysplastic naevus	Agree
3.126	Squamous cell carcinoma	Actinic keratosis	Disagree
3.127	Dysplastic naevus	Non-specific	Agree
3.128	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.129	Dysplastic naevus	Benign melanocytic naevus	Disagree
3.130	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.131	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.132	Basal cell carcinoma	Basal cell carcinoma	Agree
3.133	Actinic keratosis	Basal cell carcinoma	Disagree
3.134	Basal cell carcinoma	Basal cell carcinoma	Agree
3.135	Benign lentigo	Seborrhoeic wart	Disagree
3.136	Basal cell carcinoma	Squamous cell carcinoma	Disagree
3.137	Melanoma	Benign melanocytic naevus	Disagree
3.138	Pyogenic granuloma	Pyogenic granuloma	Agree
3.139	Actinic keratosis	Seborrhoeic wart	Disagree
3.140	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.141	Dysplastic naevus	Benign melanocytic naevus	Disagree
3.142	Seborrhoeic wart	Seborrhoeic wart	Agree
3.143	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.144	Benign melanocytic naevus	Benign melanocytic naevus	Agree

Table 15 Continued

Image	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
3.145	Lentigo maligna melanoma	Seborrhoeic wart	Disagree
3.146	Dysplastic naevus	Benign melanocytic naevus	Disagree
3.147	Basal cell carcinoma	Benign melanocytic naevus	Agree
3.148	Basal cell carcinoma	Basal cell carcinoma	Agree
3.149	Angiokeratoma	Angiokeratoma	Agree
3.150	Keratoacanthoma	Keratoacanthoma	Agree
3.151	Basal cell carcinoma	Basal cell carcinoma	Agree
3.152	Basal cell carcinoma	Nodular elastosis with comedomes	Disagree
3.153	Actinic keratosis	Actinic keratosis	Agree
3.154	Benign lentigo	Seborrhoeic wart	Disagree
3.155	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.156	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.157	Benign freckle	Benign freckle	Agree
3.158	Basal cell carcinoma	Squamous cell carcinoma	Disagree
3.159	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.160	Benign melanocytic naevus	Non-specific	Disagree
3.161	Benign melanocytic naevus	Seborrhoeic wart	Disagree
3.162	Lentigo maligna	Lentigo maligna	Agree
3.163	Squamous cell carcinoma	Squamous cell carcinoma	Agree
3.164	Dysplastic naevus	Benign melanocytic naevus	Disagree
3.165	Dermatofibroma	Dermatofibroma	Agree
3.166	Benign melanocytic naevus	Benign melanocytic naevus	Agree
3.167	Benign melanocytic naevus	Benign melanocytic naevus	Agree

The diagnosis obtained by photographic analysis agreed with the final histological diagnosis in 62% of patients (95% confidence interval 54%-70%). From details on patient referral cards, the diagnosis obtained by the general practioner (face-to-face consultation) agreed with the final histological diagnosis in 51% of patients, and diagnosis by photographic examination agreed with the general practioner diagnosis also in 51% of patients. The only significant disagreement found, between the diagnosis obtained by photographic analysis and the diagnosis obtained by histological analysis, was in one patient - diagnosed as having a seborrhoeic wart by photographic analysis, but found to have an early squamous cell carcinoma by histological assessment.

When different diagnoses were grouped together (table 16), it can be seen that squamous cell carcinoma and basal cell carcinoma were the most common diagnoses from photographic analysis of patients, followed by benign melanocytic naevus:

Table 16

Number of patients with different diagnoses, whether by photographic or histological assessment

Photographic Diagnosis		Histological Diagnosis	
Actinic keratosis	7	Actinic keratosis	1
Pyogenic granuloma	2	Pyogenic granuloma	2
Benign melanocytic naevus	30	Benign melanocytic naevus	32
Feckle or lentigo	4	Feckle or lentigo	4
Keratoacanthoma	1	Keratoacanthoma	2
Dysplastic naevus	13	Dysplastic naevus	2
Solar elastosis	0	Solar elastosis	1
Squamous cell carcinoma	31	Squamous cell carcinoma	20
Basal cell carcinoma	31	Basal cell carcinoma	31
Seborrhoeic wart	10	Seborrhoeic wart	11
Bowen's disease	1	Bowen's disease	0
Adnexal tumour	1	Adnexal tumour	3
Angiokeratoma	2	Angiokeratoma	2
Sebaceous cyst	1	Sebaceous cyst	1
Dermatofibroma	2	Dermatofibroma	3
Chondrodermatitis nodularis helicis	0	Chondrodermatitis nodularis helicis	1
Squamous papilloma	1	Squamous papilloma	3
Melanoma	4	Melanoma	1
Non - specific	0	Non - specific	10
Nodular elastosis	0	Nodular elastosis	1
Total	141	Total	141

There were more non-specific histological than photographic diagnoses. Malignancy (excluding actinic keratoses and dysplastic naevi) was diagnosed in 67 patients by photographic assessment and 52 patients by histological analysis - an excess of 15 patients.

3.4.4 Discussion

The diagnostic accuracy in this study was 62%, less than in the earlier pilot study (study 1). However, in only one patient was the disagreement between the diagnosis of photographic and histological assessment of clinical significance, although it was unlikely to have influenced treatment - since the lesion was not an aggressive carcinoma. An excess diagnosis of skin malignancy by photographic assessment was noticed in this study, as in the previous pilot study (Study 1). In the present study, unlike in the early pilot study, the conventional photographs had been taken in the medical illustration department, rather than in the photographic studio. The lower diagnostic accuracy in this study did not appear to be related to inferior image quality or resolution.

Would it be more useful for the photographic assessment to distinguish between benign and malignant skin tumours and predict treatment, rather than accurately assess the diagnosis? To assess whether conventional photography could be of practical use for the management of patients with skin tumours, a larger study was designed, across three hospital centres in Lancaster, Kendal and Barrow.

CHAPTER 4

SKIN TUMOUR MANAGEMENT BY CONVENTIONAL PHOTOGRAPHY

4.1 Study 4. Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay

Having undertaken initial pilot studies (1 and 3) to assess whether conventional photographic images could be used for the diagnosis and management of skin tumours, a larger study was undertake across three hospital sites in Lancaster, Kendal and Barrow.

4.1.1 Introduction

Dermatology waiting lists are a national problem. A significant proportion of general practitioner referrals to dermatology departments (greater than 50%) are related to skin tumours (personal observations). Traditionally, patients attend hospital clinics, and are often on lengthening lists for treatment. A study was planned, across three hospital sites (Lancaster, Kendal and Barrow) to examine whether conventional photography could be used to help in the management of patients with skin tumours.

4.1.2 Methods

Over a six month period, December 1996 to May 1997, patients were invited to attend a photography session for the imaging of skin lesions. Consecutive patient referrals, from general practitioners, were asked to take part in the study, if they had a skin lesion (tumour) which was in a suitable site for photography. Exclusions included sites obscured by hair or other body features and tumours in genital sites. Furthermore, patients who were immobile or unable to attend for photography and who had significant medical problems (which could have

necessitated special transport or escort for the patient) were excluded from the study.

Patients were invited to attend either the medical illustration department at Royal Lancaster Infirmary, Lancaster, or the out-patient department at Westmorland General Hospital, Kendal or Furness General Hospital, Barrow. Patients in the medical illustration department had photographs taken in the photographic studio and patients attending the out-patient departments at Westmorland General Hospital, Kendal or Furness General Hospital, Barrow had photographs taken in a clinic room chosen to give similar lighting conditions to the photographic studio in Lancaster. Photographs were taken using a Nikon FM2 camera (figure 2.1) by a professional medical photographer.

Patients were sent a letter of invitation to attend the photographic session - and were given an option of being able to attend a hospital clinic, rather than the photographic session, if they preferred to see the dermatologist rather attend for photography. Patients were scheduled to attend for photography by the medical photographer at either 10 or 15 minute intervals, to have the skin lesion or lesions photographed (the longer time for more complicated or more numerous skin lesions) and a conventional photograph was taken of the skin problem for image analysis. A measurement rule was photographed alongside each skin tumour which enabled, where necessary, tumour size measurement. In addition, the patient record number was also photographed alongside the skin tumour, which ensured later identification of the photograph. In this study, as with the other conventional studies, skin tumours were photographed at a magnification of 1:2, but with a final print magnification of 1.5:1. The colour photographs were usually available for analysis by the dermatologist within five days after the taking of the photographic image.

The patient's notes were available with each image, together with the general practitioner referral details, to help with the dermatological assessment. Once the diagnosis had been assessed from the photographic image, a letter was sent to the general practitioner, and furthermore, a letter concerning the skin problem was sent to the patient. The letter to the general practitioner explained the diagnosis or differential diagnosis, and the planned treatment. Similarly, a letter sent to the patient indicated the planned management of the skin problem, but also offered reassurance to the patient.

After image assessment, the patient's relevant skin lesion was removed when necessary, the time duration from image assessment to skin surgery depending upon the degree of urgency given to the skin problem after image analysis (and also took into consideration the general practioner referral details and urgency of referral).

Subsequent tumour removal, when necessary, gave the opportunity to assess the diagnostic accuracy from photographic assessment compared with the histological diagnosis. The appropriateness of treatment was assessed by comparing the photographic recommendation with the actual treatment subsequently performed.

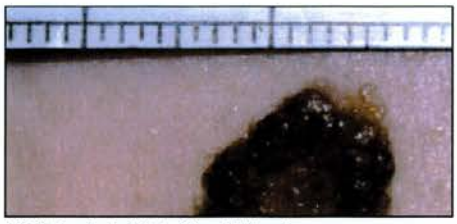
4.1.3 Results

Over the study period (6 months), up to 25 patients attended photographic sessions on a weekly basis. Each photographic clinic on average lasted approximately 30 minutes and during the 6 months, 656 patients had photographic assessment, 248 males and 408 females, mean age 53.6yrs, range 1yr - 95yrs. Most patients had photographic images of single skin tumours, but a significant proportion (35%) had images taken of more than one skin lesion (range 2 - 9, mean 2.5), at the discretion of the medical photographer or patient. The photographs of the skin tumours in the study, with an indication of patient's age and photographic diagnosis, are shown on Figures 4.1 to 4.656:

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

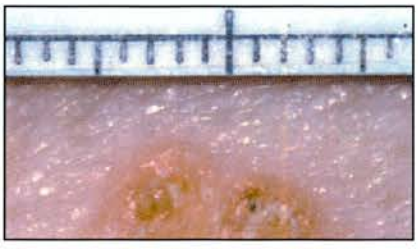
Images standardised for each patient

4.1 Actinic Keratosis. 56yr old male.



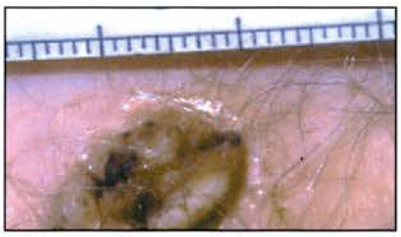
4.2 Seborrhoeic Wart. 63yr old female.

4.3 Psoriatic Plaque. 6yr old female



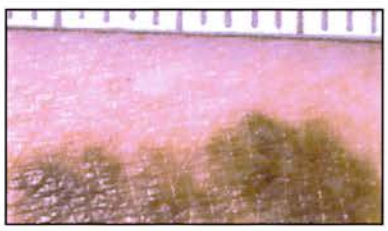
4.4 Squamous Cell Carcinoma. 62 yr old male

4.5 Squamous Cell Carcinoma. 65 yr old female



4.6 Pyogenic Granuloma. 10yr female

4.7 Actinic Keratosis. 81 yr old male

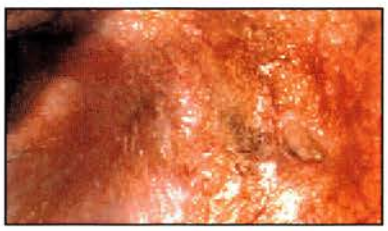


4.8 Basal Cell Carcinoma. 52 yr old male

4.9 Viral Wart. 19yr old male

4.10 Actinic Keratosis 85 yr old female

4.11 Seborrhoeic Wart. 64 yr old male



4.12 Squamous Cell Carcinoma. 83 yr old male

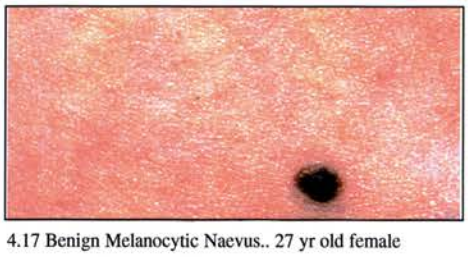
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.13 Squamous Cell Carcinoma. 45yr old female

4.14 Squamous Cell Carcinoma. 78 yr old female

4.15 Basal Cell Carcinoma. 62 yr old male

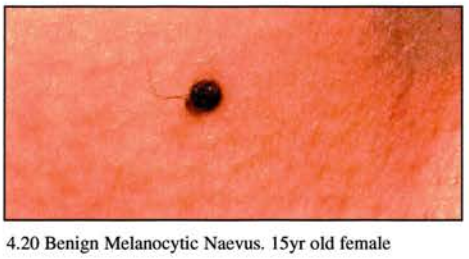
4.16 Benign Melanocytic Naevus.. 30 yr old female



4.17 Benign Melanocytic Naevus.. 27 yr old female

4.18 Benign Melanocytic Naevus. 49yr old female

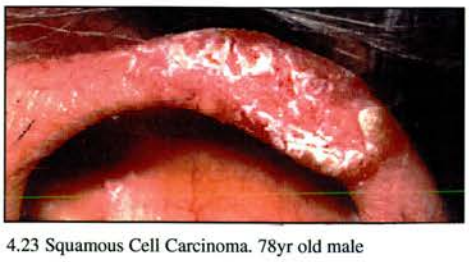
4.19 Basal Cell Carcinoma. 55yr old female



4.20 Benign Melanocytic Naevus. 15yr old female

4.21 Seborrhoeic Wart. 62yr old male

4.22 Actinic Keratosis. 66yr old male



4.23 Squamous Cell Carcinoma. 78yr old male

4.24 Basal Cell Carcinoma. 58 yr old female

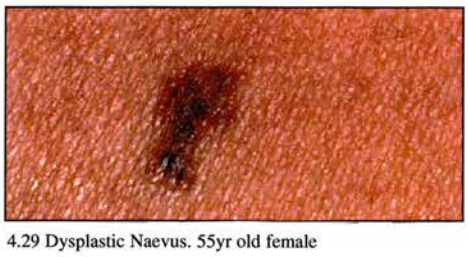
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.25 Squamous Cell Carcinoma. 76yr old female

4.26 Dysplastic Naevus. 26yr old male

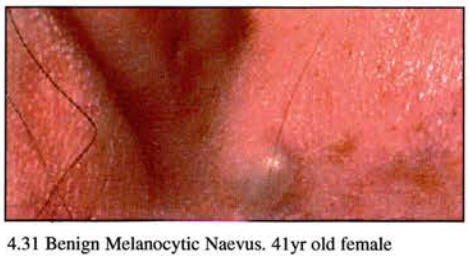
4.27 Seborrhoeic Wart. 73 yr old female

4.28 Lentigo Maligna. 73yr old female



4.29 Dysplastic Naevus. 55yr old female

4.30 Benign Melanocytic Naevus. 26yr old female

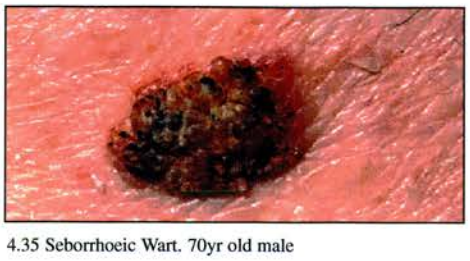


4.31 Benign Melanocytic Naevus. 41yr old female

4.32 Spider Naevus. 36yr old male

4.33 Benign Melanocytic Naevus. 36yr old female

4.34 Bowen's Disease. 75yr old female



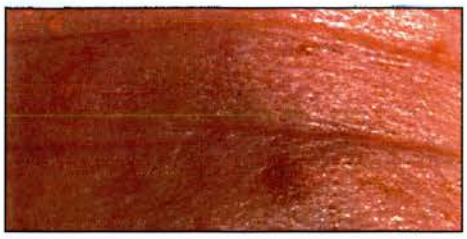
4.35 Seborrhoeic Wart. 70yr old male

4.36 Viral Wart. 1yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

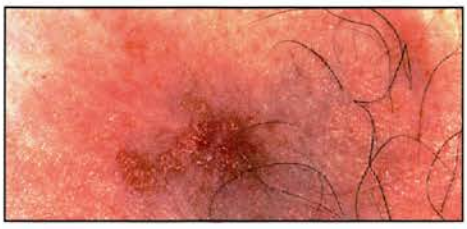
4.37 Benign Melanocytic Naevus. 23yr old female

4.38 Squamous Cell Carcinoma. 84yr old male



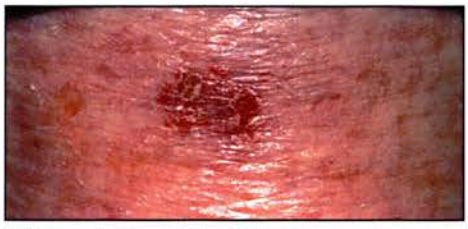
4.39 Benign Melanocytic Naevus. 38yr old male

4.40 Melanoma. 61yr old male



4.41 Basal Cell Carcinoma. 68yr old male

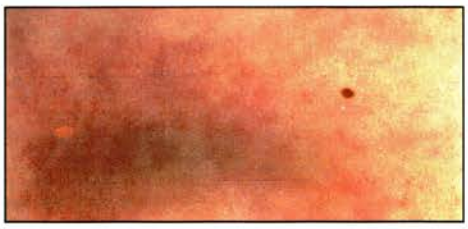
4.42 Squamous Cell Carcinoma. 79yr old female



4.43 Bowen's Disease. 72yr old female

4.44 Bowen's Disease. 67yr old female

4.45 Basal Cell Carcinoma. 66yr old male



4.46 Haemangioma .5yr old female

4.47 Benign Melanocytic Naevus. 68yr old female

4.48 Seborrhoeic Warts. 71yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.49 Benign Melanocytic Naevus. 36yr old female

4.50 Seborrhoeic Wart. 14yr old female

4.51 Seborrhoeic Wart. 56yr old male

4.52 Squamous Cell Carcinoma. 66yr old male

4.53 Actinic Keratosis. 61yr old male

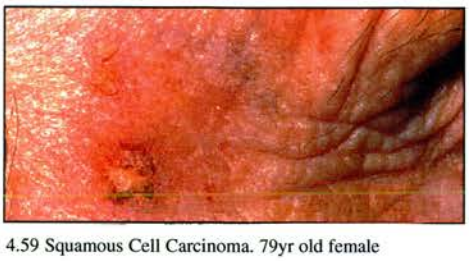
4.54 Basal Cell Carcinoma. 69yr old female

4.55 Non - specific. 14yr old female

4.56 Squamous Cell Carcinoma. 74yr old female

4.57 Squamous Cell Carcinoma. 52yr old male

4.58 Actinic Keratosis. 71yr old male



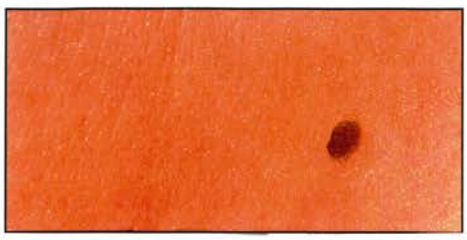
4.59 Squamous Cell Carcinoma. 79yr old female

4.60 Actinic Keratosis. 74yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.61 Non - specific. 27yr old female

4.62 Seborrhoeic Wart. 65yr old female



4.63 Benign Melanocytic Naevus. 25yr old male

4.64 Keloid. 58yr old female

4.65 Squamous Cell Carcinoma. 73yr old male

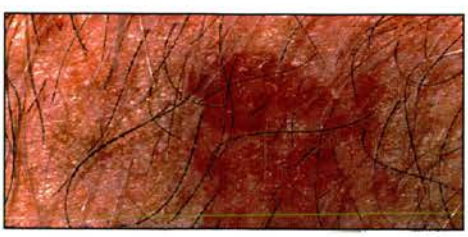
4.66 Benign Melanocytic Naevus. 79yr old male

4.67 Benign Melanocytic Naevus. 53yr old female

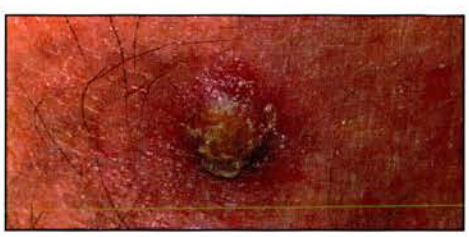
4.68 Dysplastic Naevus. 15yr old female

4.69 Basal Cell Carcinoma. 88yr old male

4.70 Basal Cell Carcinoma. 64yr old male



4.71 Bowen's Disease. 61yr old male



4.72 Squamous Cell Carcinoma. 76yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.73 Seborrhoeic Wart. 83yr old female

4.74 Seborrhoeic Wart 66yr old female

4.75 Squamous Cell Carcinoma. 90yr old female

4.76 Squamous Cell Carcinoma. 75yr old female

4.77 Benign Melanocytic Naevus. 16yr old male

4.78 Squamous cell carcinoma. 77yr old female

4.79 Benign melancytic Naevus. 28yr old female

4.80 Squamous Cell Carcinoma. 89yr old female

4.81 Bowen's Disease. 89yr old female

4.82 Benign Melanocytic Naevus. 26yr old female

4.83 Basal Cell Carcinoma. 55yr old female

4.84 Benign Melanocytic Naevus. 26yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.85 Benign Melanocytic Naevus. 16yr old female

4.86 Bowen's Disease. 69yr old female

4.87 Bowen's Disease. 74yr old female

4.88 Chondrodermatitis Nodularis Helicis. 70yr old male

4.89 Basal Cell Carcinoma. 76yr old male

4.90 Basal Cell Carcinoma. 73yr old male

4.91 Basal Cell Carcinoma. 75yr old female

4.92 Bowen's Disease. 67yr old female

4.93 Basal Cell Carcinoma. 65yr old female

4.94 Basal Cell Carcinoma. 62yr old female

4.95 Viral Wart. 33yr old female

4.96 Squamous Cell Carcinoma. 77yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

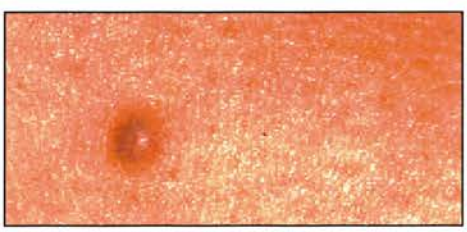
4.97 Rosacea. 27yr old female

4.98 Bowen's Disease. 67yr old female

4.99 Squamous Cell Carcinoma. 62yr old male

4.100 Benign Melanocytic Naevus. 14yr old female

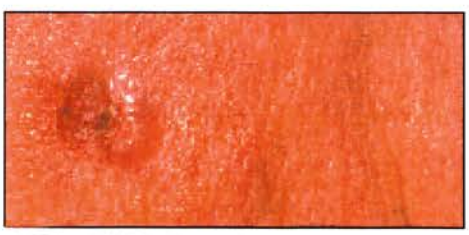
4.101 Bowen's Disease. 68yr old female



4.102 Dermatofibroma. 23yr old female

4.103 Squamous Cell Carcinoma. 62yr old male

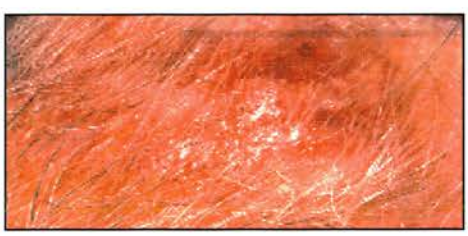
4.104 Basal Cell Carcinoma. 89yr old female



4.105 Basal Cell Carcinoma. 62yr old male

4.106 Bowen's Disease. 72yr old female

4.107 Squamous Cell Carcinoma. 73yr old female



4.108 Basal Cell Carcinoma. 71yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.109 Basal Cell Carcinoma. 91yr old female

4.110 Epidermal Naevus. 13yr old female

4.111 Bowen's Disease. 70yr old female

4.112 Basal Cell Carcinoma. 69yr old female

4.113 Benign Melanocytic Naevus. 48yr old female

4.114 Basal Cell Carcinoma. 85yr old male

4.115 Benign Lentigo. 77yr old female

4.116 Benign Freckle/Lentigo. 64yr old male

4.117 Benign Lentigo. 44yr old female

4.118 Benign Hyperkeratosis. 60yr old female

4.119 Basal Cell Carcinoma. 64yr old female

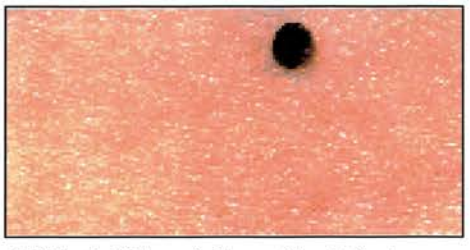
4.120 Squamous Cell Carcinoma. 65yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

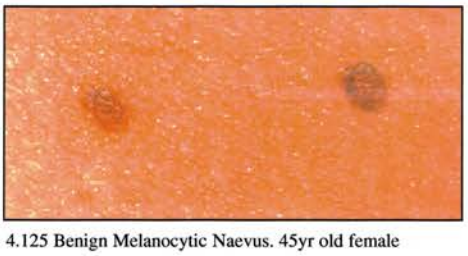
4.121 Squamous Cell Carcinoma. 83yr old male

4.122 Chondrodermatitis Nodularis Helicis. 70yr old female

4.123 Squamous Cell Carcinoma. 85yr old male

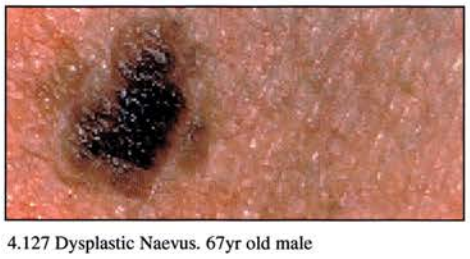


4.124 Benign Melanocytic Naevus. 30yr old female



4.125 Benign Melanocytic Naevus. 45yr old female

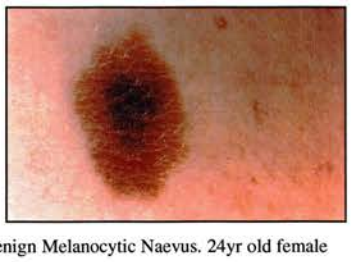
4.126 Seborrhoeic Wart. 73yr old male



4.127 Dysplastic Naevus. 67yr old male

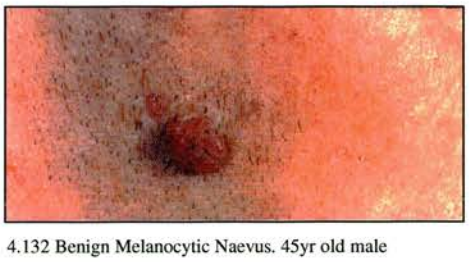
4.128 Seborrhoeic Wart. 52yr old female

4.129 Seborrhoeic Wart. 76yr old female



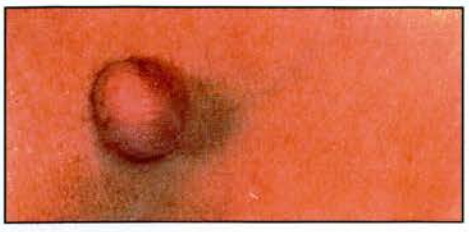
4.130 Benign Melanocytic Naevus. 24yr old female

4.131 Benign Melanocytic Naevus. 76yr old female



4.132 Benign Melanocytic Naevus. 45yr old male

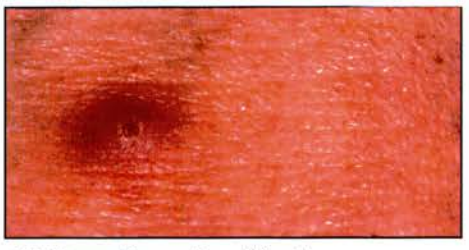
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.



4.133 Benign Melanocytic Naevus. 61yr old female

4.134 Benign Melanocytic Naevus. 64yr old male

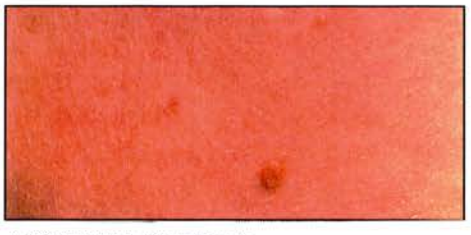
4.135 Squamous Cell Carcinoma. 93yr old male



4.136 Dermatofibroma. 43yr old female

4.137 Basal Cell Carcinoma. 59yr old male

4.138 Viral Wart. 31yr old male

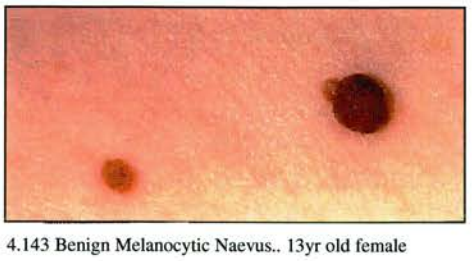


4.139 Viral Wart. 13yr old male

4.140 Seborrhoeic Wart. 50yr old female

4.141 Seborrhoeic Wart. 56yr old female

4.142 Seborrhoeic Wart. 62yr old female



4.143 Benign Melanocytic Naevus.. 13yr old female

4.144 Basal Cell Carcinoma. 61yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

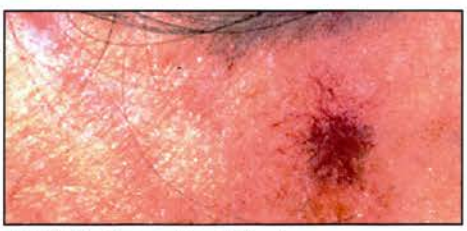
4.145 Benign Melanocytic Naevus. 15yr old male

4.146 Actinic Keratosis. 66yr old female

4.147 Sebaceous Cyst. 43yr old male

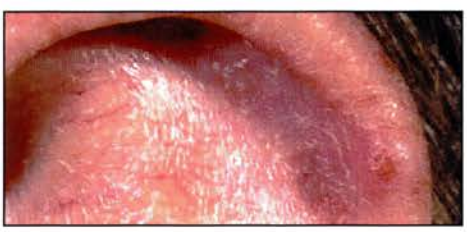
4.148 Sebaceous Cyst. 58yr old male

4.149 Sebaceous Cyst. 43yr old female



4.150 Spider Naevus. 76yr old female

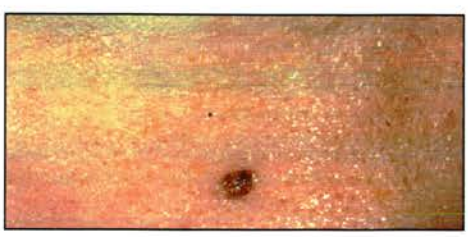
4.151 Benign Melanocytic Naevus. 21yr old female



4.152 Chondrodermatitis Nodularis Helicis. 59yr old male

4.153 Benign Melanocytic Naevus. 32yr old female

4.154 Non-specific. 47yr old male

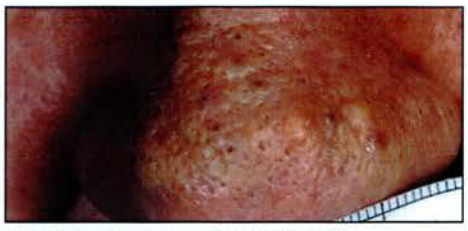


4.155 Benign Melanocytic Naevus. 35yr old female

4.156 Adnexal Tumour. 22yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.157 Spider Naevus. 8yr old male



4.158 Sebaceous Hyperplasia. 66yr old male

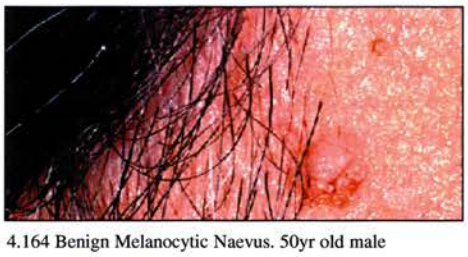
4.159 Pigmented Actinic Keratosis. 60yr old female

4.160 Non-specific. 47yr old female

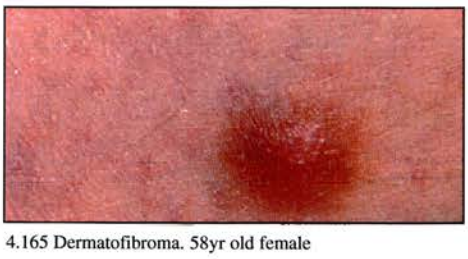
4.161 Benign Freckle/Lentigo. 81yr old female

4.162 Dermatofibroma. 43yr old female

4.163 Seborrhoeic Wart. 75yr old female



4.164 Benign Melanocytic Naevus. 50yr old male



4.165 Dermatofibroma. 58yr old female

4.166 Actinic Keratosis. 57yr old female

4.167 Benign Melanocytic Naevus. 15yr old male

4.168 Seborrhoeic Wart. 28yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

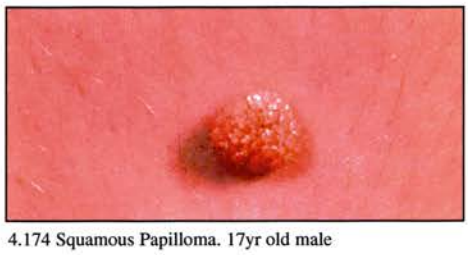
4.169 Dermatofibroma. 21yr old female

4.170 Benign Melanocytic Naevus. 20yr old female

4.171 Chondrodermatitis Nodularis Helicis. 59yr old male

4.172 Actinic Keratosis. 52yr old female

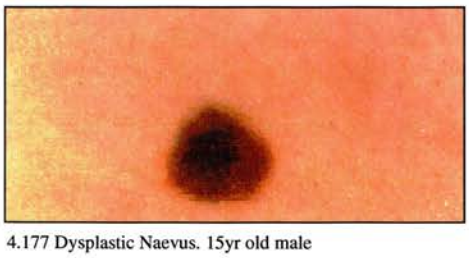
4.173 Squamous Cell Carcinoma. 68yr old male



4.174 Squamous Papilloma. 17yr old male

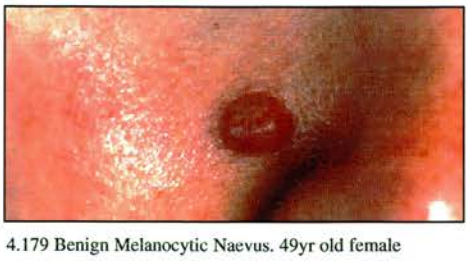
4.175 Squamous Cell Carcinoma. 56yr old male

4.176 Sebaceous Cyst. 48yr old male

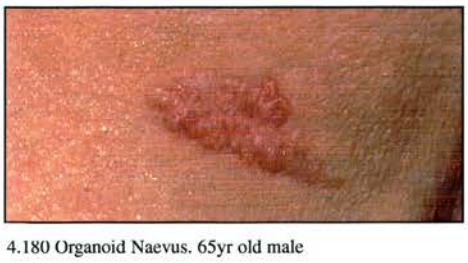


4.177 Dysplastic Naevus. 15yr old male

4.178 Keloid. 31yr old male



4.179 Benign Melanocytic Naevus. 49yr old female



4.180 Organoid Naevus. 65yr old male

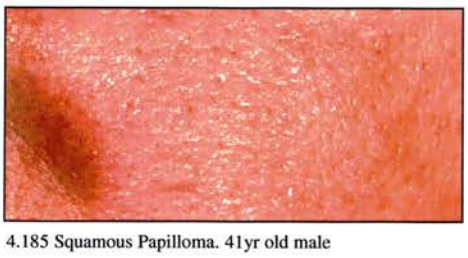
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.181 Benign Melanocyticl Naevus. 76yr old male

4.182 Squamous Cell Carcinoma. 71yr old female

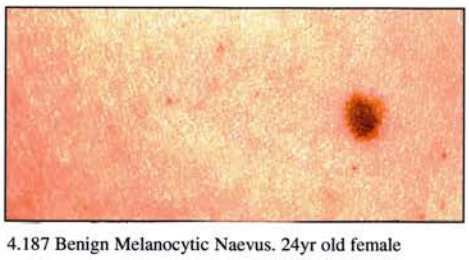
4.183 Benign Melanocytic Naevus. 44yr old male

4.184 Sebaceous Cyst. 67yr old female



4.185 Squamous Papilloma. 41yr old male

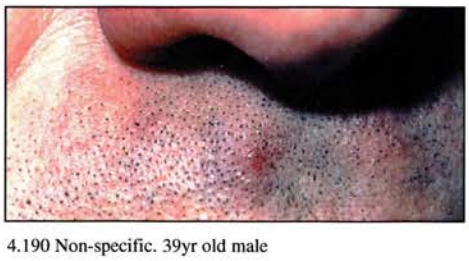
4.186 Seborrhoeic Wart. 72yr old female



4.187 Benign Melanocytic Naevus. 24yr old female

4.188 Seborrhoeic Wart. 58yr old female

4.189 Benign Melanocytic Naevus. 57yr old female



4.190 Non-specific. 39yr old male

4.191 Non-specific. 35yr old female

4.192 Skin Tag. 39yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.193 Benign Melanocytic Naevus. 16yr old female

4.194 Non-specific. 73yr old female

4.195 Seborrhoeic Wart with Cutaneous Horn 79yr old female

4.196 Non-specific. 34yr old female

4.197 Basal Cell Carcinoma. 76yr old female

4.198 Viral Wart with Cutaneous Horn. 53yr old female

4.199 Dermatofibroma. 30yr old female

4.200 Seborrhoeic Wart. 86yr old female

4.201 Viral Wart. 36yr old male

4.202 Sebaceous Cyst. 30yr old female

4.203 Viral Wart. 35yr old female

4.204 Seborrhoeic Wart. 68yr old male

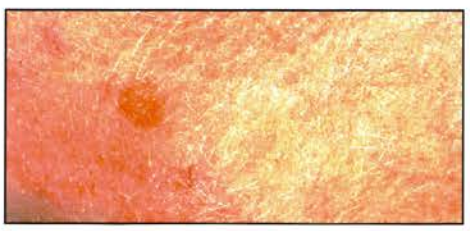
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.205 Haemangioma. 38yr old male

4.206 Non - Specific. 74yr old female

4.207 Viral Warts. 51yr old female

4.208 Squamous Cell Carcinoma. 67yr old female



4.209 Benign Melanocytic Naevus. 50yr old female

4.210 Benign Melanocytic Naevuss. 29yr old female

4.211 Benign Melanocytic Naevus. 32yr old female

4.212 Spider Naevus. 10yr old male

4.213 Benign Melanocytic Naevus 50yr old male

4.214 Seborrhoeic Wart. 57yr old female

4.215 Viral Wart. 13yr old male

4.216 Actinic Keratosis. 58yr old female

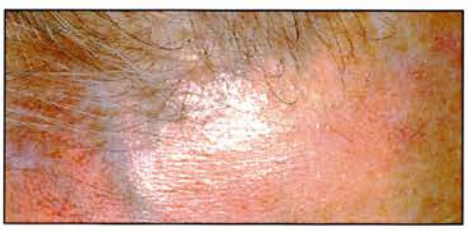
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.217 Benign Melanocytic Naevus. 70yr old female

4.218 Seborrhoeic Wart. 60yr old female

4.219 Haemangioma. 71yr old female

4.220 Actinic Keratosis. 64yr old female



4.221 Actinic Keratosis. 71yr old male

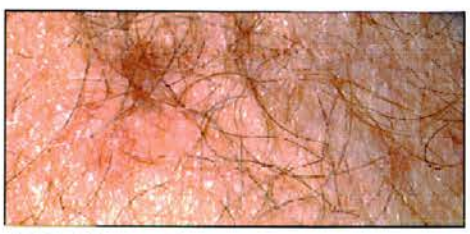
4.222 Seborrhoeic Wart. 58yr old female

4.223 Bowen's Disease. 93yr old female

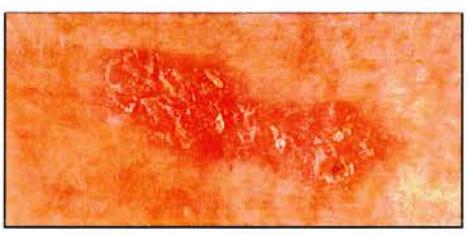
4.224 Benign Melanocytic Naevus. 55yr old female

4.225 Dysplastic Naevus. 35yr old male

4.226 Non-Specific. 75yr old female



4.227 Actinic Keratosis. 55yr old male



4.228 Bowen's Disease. 84yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

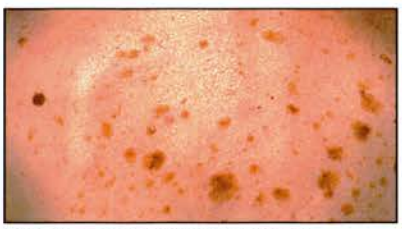
4.229 Sebaceous Cyst. 36yr old male

4.230 Dermatofibroma. 31yr old female

4.231 Basal Cell Carcinoma. ??yr old male

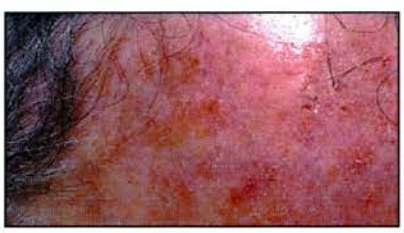
4.232 Dermatofibroma. 29yr old female

4.233 Spitz Naevus. 16yr old female



4.234 Seborrhoeic Wart. 61yr old female

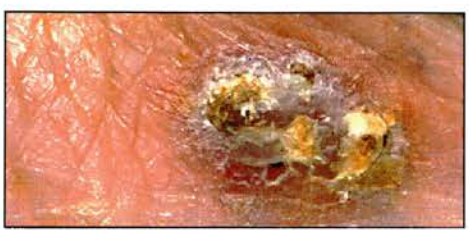
4.235 Morphoea.44yr old male



4.236 Actinic Keratosis. 68yr old male

4.237 Viral Warts. 14yr old female

4.238 Actinic Keratosis. 56yr old female



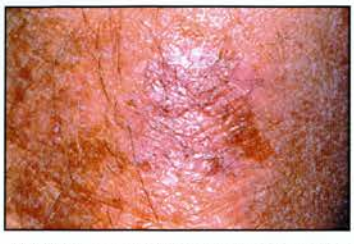
4.239 Squamous Cell Carcinoma. 75yr old female

4.240 Benign Melanocytic Naevus. 63yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.241 Basal Cell Carcinoma. 68yr old male

4.242 Eczema. 66yr old female

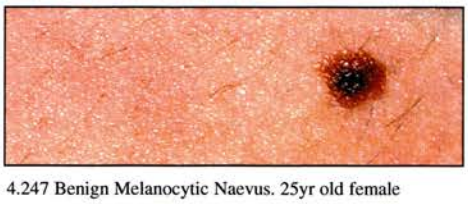


4.243 Squamous Cell Carcinoma. 73yr old female

4.244 Chondrodermatitis Nodularis Helicis. 44yr old female

4.245 Bowen's Disease. 72yr old female

4.246 Actinic Keratosis. 54yr old female



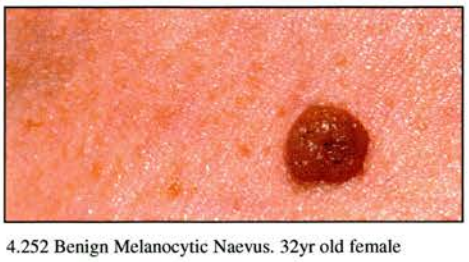
4.247 Benign Melanocytic Naevus. 25yr old female

4.248 Seborrhoeic Wart. 47yr old female

4.249 Basal Cell Carcinoma. 81yr old female

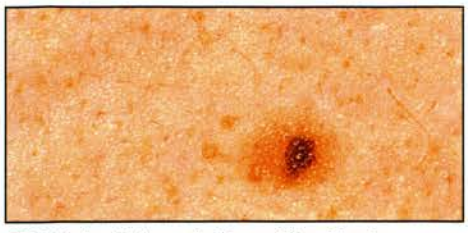
4.250 Basal Cell Carcinoma. 74yr old male

4.251 Actinic Keratosis. 57yr old female



4.252 Benign Melanocytic Naevus. 32yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

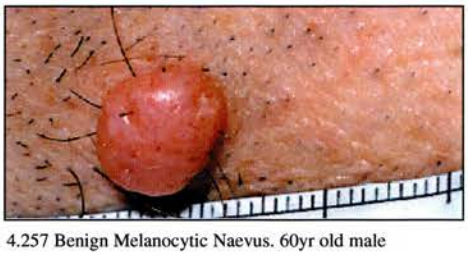


4.253 Benign Melanocytic Naevus. 29yr old male

4.254 Seborrhoeic Wart. 56yr old female

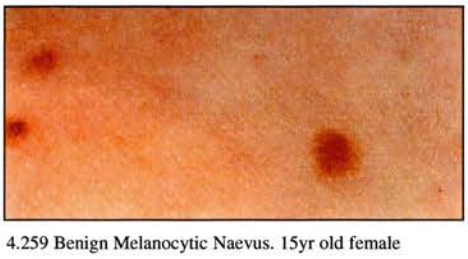
4.255 Viral Wart. 74yr old female

4.256 Digital Mucous cyst. 65yr old male



4.257 Benign Melanocytic Naevus. 60yr old male

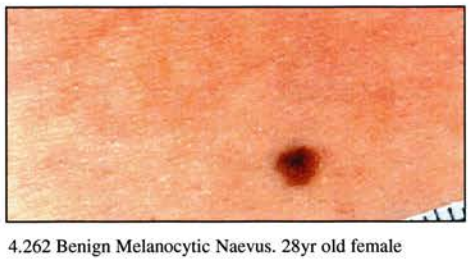
4.258 Squamous Cell Carcinoma. 53yr old female



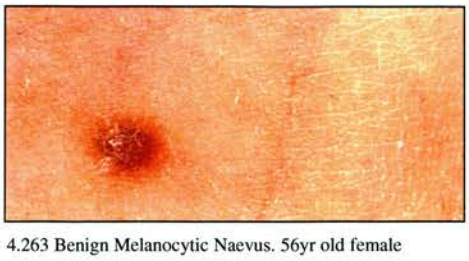
4.259 Benign Melanocytic Naevus. 15yr old female

4.260 Squamous Cell Carcinoma. 47yr old male

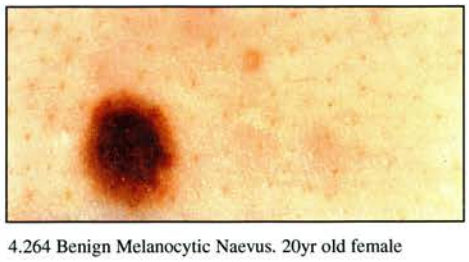
4.261 Basal Cell Carcinoma. 55yr old female



4.262 Benign Melanocytic Naevus. 28yr old female



4.263 Benign Melanocytic Naevus. 56yr old female



4.264 Benign Melanocytic Naevus. 20yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.265 Blue Naevus. 15yr old female

4.266 Actinic Keratosis. 52yr old female

4.267 Acne. 36yr old female

4.268 Basal Cell Carcinoma. 69yr old female

4.269 Squamous Cell Carcinoma. 69yr old male

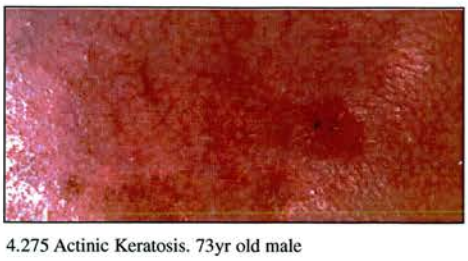
4.270 Benign Melanocytic Naevus. 86yr old male

4.271 Basal Cell Carcinoma. 60yr old male

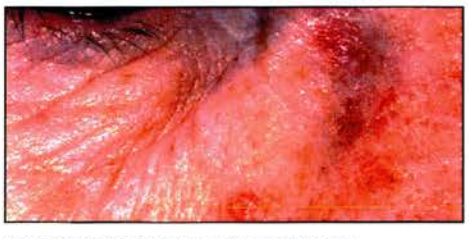
4.272 Actinic Keratosis. 62yr old male

4.273 Bowen's Disease. 74yr old male

4.274 Benign Melanocytic Naevus. 48yr old female



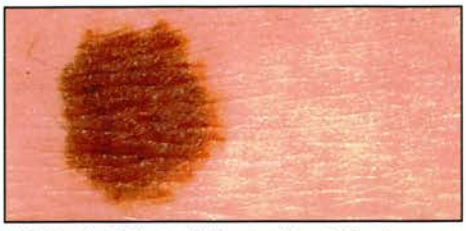
4.275 Actinic Keratosis. 73yr old male



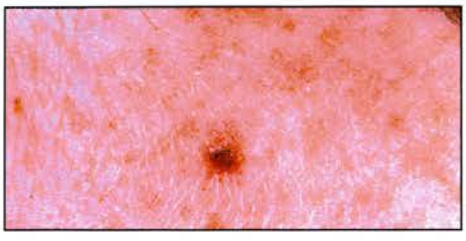
4.276 Basal Cell Carcinoma. 61yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.277 Sebaceous Cyst. 33yr old female

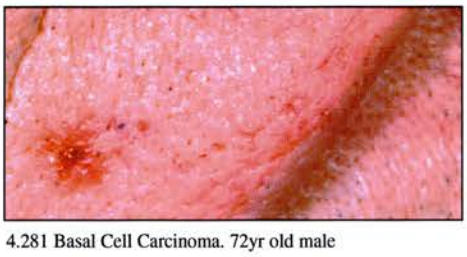


4.278 Benign Melanocytic Naevus. 43yr old female



4.279 Benign Melanocytic Naevus. 46yr old female

4.280 Milium. 80yr old female



4.281 Basal Cell Carcinoma. 72yr old male

4.282 Digital Mucous Cyst. 59yr old female

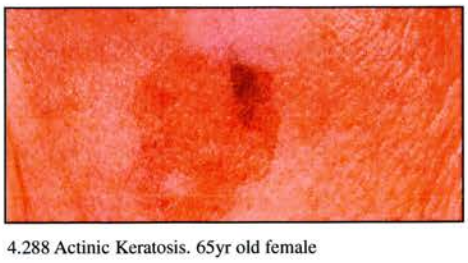
4.283 Basal Cell Carcinoma. 95yr old female

4.284 Blue Naevus. 70yr old male

4.285 Basal Cell Carcinoma. 34yr old male

4.286 Benign Melanocytic Naevus. 36yr old female

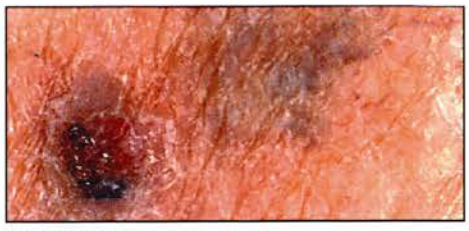
4.287 Non-specific. 13yr old male



4.288 Actinic Keratosis. 65yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.289 Non-specific. 70yr old male

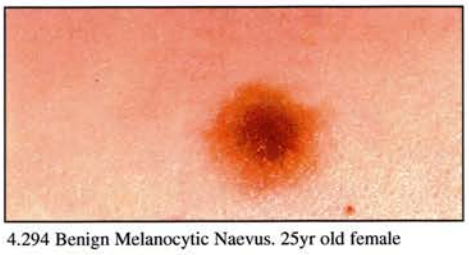


4.290 Melanoma. 62yr old female

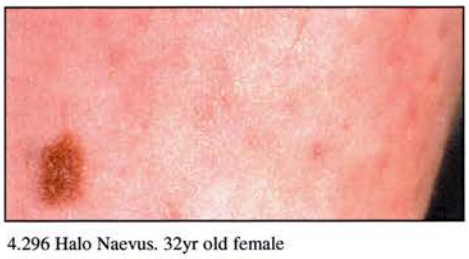
4.291 Squamous Cell Carcinoma. 58yr old male

4.292 Squamous Cell Carcinoma. 72yr old female

4.293 Benign Melanocytic Naevus. 36yr old male

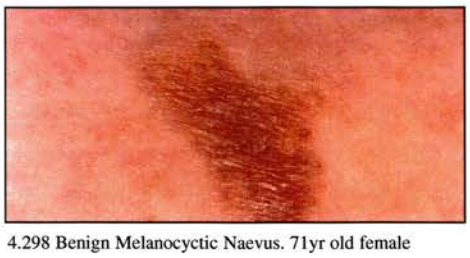


4.294 Benign Melanocytic Naevus. 25yr old female

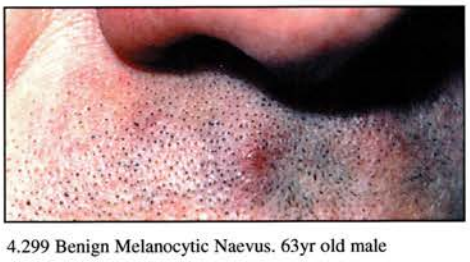


4.296 Halo Naevus. 32yr old female

4.297 Basal Cell Carcinoma. 63yr old male

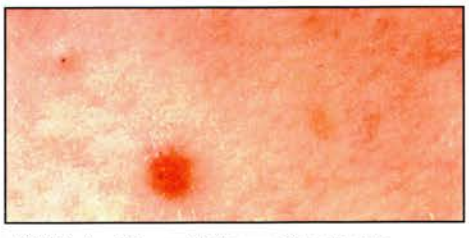


4.298 Benign Melanocyctic Naevus. 71yr old female



4.299 Benign Melanocytic Naevus. 63yr old male

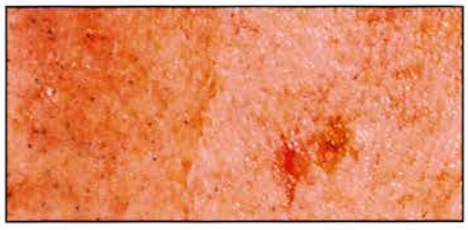
4.300 Viral Wart. 59yr old female



4.301 Benign Melanocytic Naevus. 20yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.302 Dermatofibroma. 42yr old female

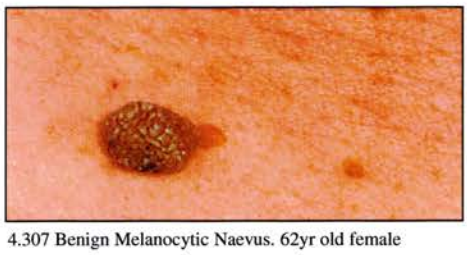


4.303 Basal Cell Carcinoma. 42yr old male

4.304 Dysplastic Naevus. 40yr old female

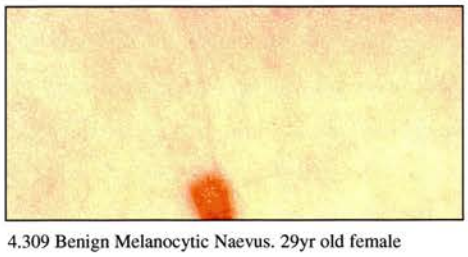
4.305 Benign Melanocytic Naevus. 43yr old female

4.306 Squamous Cell Carcinoma. 82yr old female



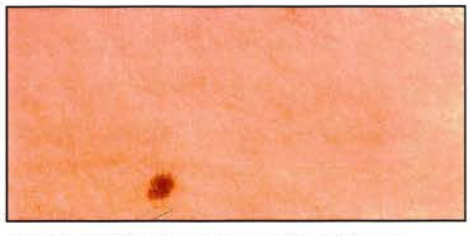
4.307 Benign Melanocytic Naevus. 62yr old female

4.308 Seborrhoiec Wart. 64yr old male

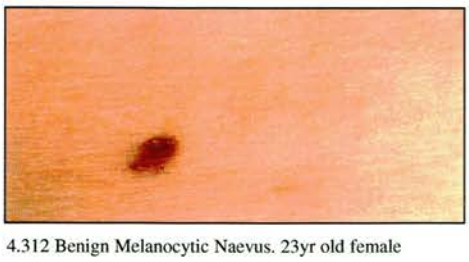


4.309 Benign Melanocytic Naevus. 29yr old female

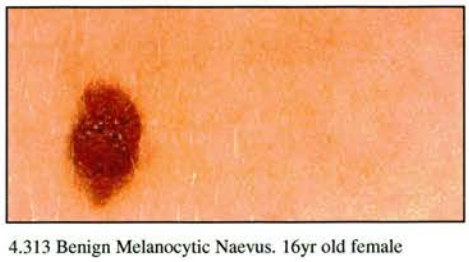
4.310 Haemangioma. 8yr old female



4.311 Benign Melanocytic Naevus. 31yr old female



4.312 Benign Melanocytic Naevus. 23yr old female



4.313 Benign Melanocytic Naevus. 16yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

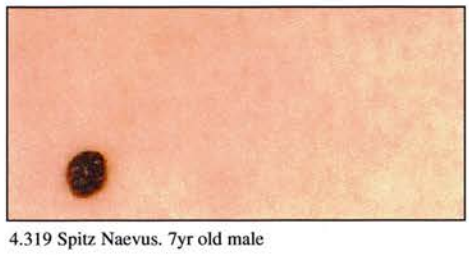
4.314 Basal Cell Carcinoma. 51yr old female

4.315 Seborrhoiec Wart. 84yr old female

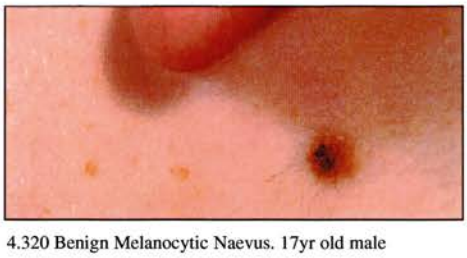
4.316 Non-specific. 49yr old male

4.317 Actinic Keratosis. 52yr old female

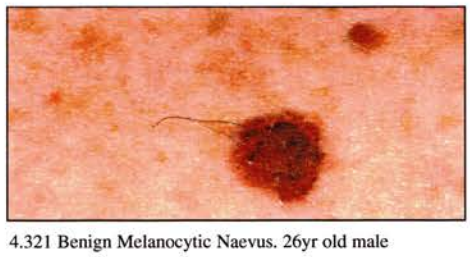
4.318 Actinic Keratosis. 46yr old male



4.319 Spitz Naevus. 7yr old male



4.320 Benign Melanocytic Naevus. 17yr old male

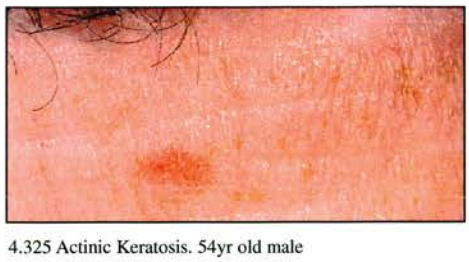


4.321 Benign Melanocytic Naevus. 26yr old male

4.322 Benign Melanocytic Naevus. 20yr old female

4.323 Basal Cell Carcinoma. 66yr old female

4.324 Actinic Keratosis. 55yr old female



4.325 Actinic Keratosis. 54yr old male

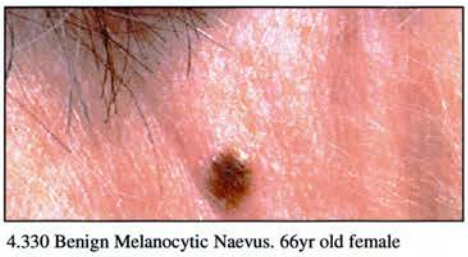
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.326 Dysplastic Naevus. 52yr oldmale

4.327 Basal Cell Carcinoma. 58yr old male

4.328 Benign Melanocytic Naevus. 33yr old female

4.329 Benign Melanocytic Naevus. 55yr old male



4.330 Benign Melanocytic Naevus. 66yr old female

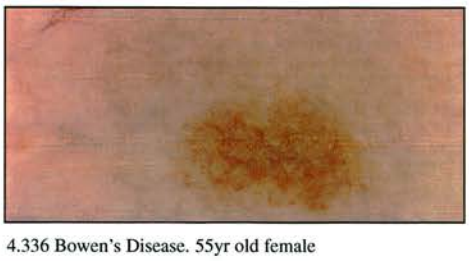
4.331 Actinic Keratosis . 75yr old female

4.332 Benign Melanocytic Naevus. 48yr old male

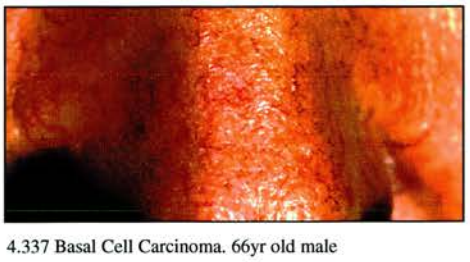
4.333 Actinic Keratosis. 91yr old female

4.334 Squamous Cell Carcinoma. 64yr old female

4.335 Squamous Cell Carcinoma. 55yr old female



4.336 Bowen's Disease. 55yr old female

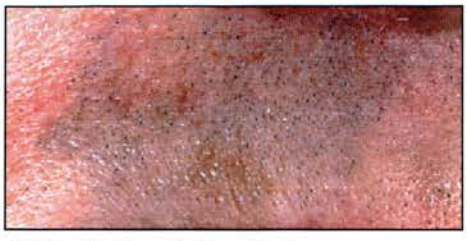


4.337 Basal Cell Carcinoma. 66yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.338 Actinic Keratosis. 59yr old male

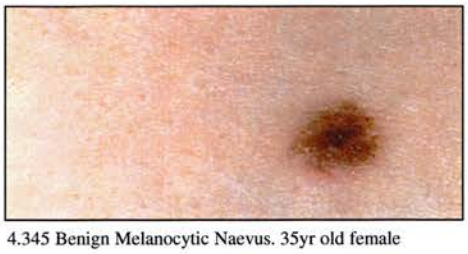
4.341 Seborrhoeic Wart. 60yr old male



4.342 Actinic Keratosis. 55yr old male

4.343 Keloid. 17yr old female

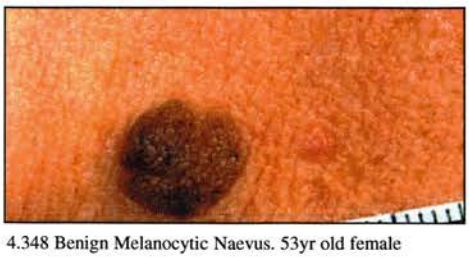
4.344 Adnexal Tumour. 34yr old female



4.345 Benign Melanocytic Naevus. 35yr old female

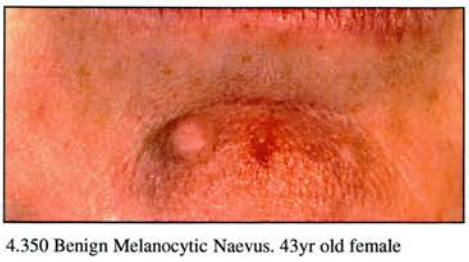
4.346 Bowen's Disease. 46yr old male

4.347 Actinic Keratosis. 87yr old male

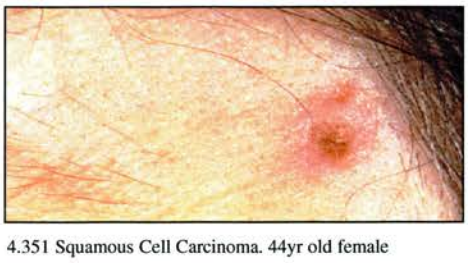


4.348 Benign Melanocytic Naevus. 53yr old female

4.349 Benign Cyst. 74yr old male



4.350 Benign Melanocytic Naevus. 43yr old female



4.351 Squamous Cell Carcinoma. 44yr old female

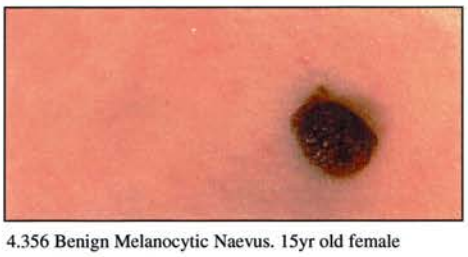
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.352 Squamous Cell Carcinoma. 62yr old female

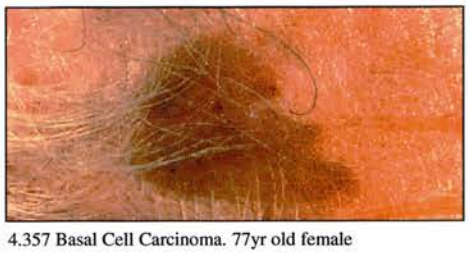
4.353 Benign Melanocytic Naevus. 27yr old male

4.354 Bowen's Disease. 56yr old female

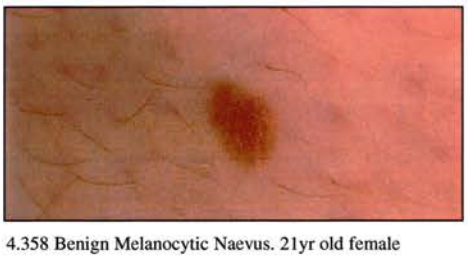
4.355 Dermatofibroma. 42yr old female



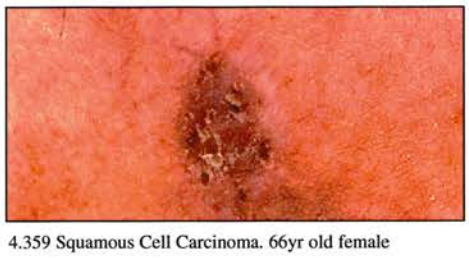
4.356 Benign Melanocytic Naevus. 15yr old female



4.357 Basal Cell Carcinoma. 77yr old female

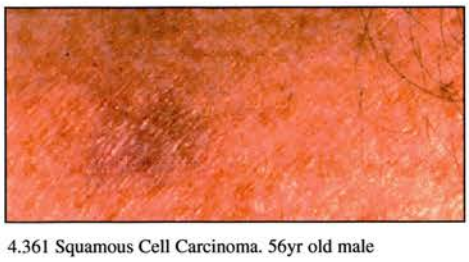


4.358 Benign Melanocytic Naevus. 21yr old female



4.359 Squamous Cell Carcinoma. 66yr old female

4.360 Basal Cell Carcinoma. 36yr old male



4.361 Squamous Cell Carcinoma. 56yr old male

4.362 Melanoma in Situ. 65yr old female

4.363 Basal Cell Carcinoma. 68yr old male

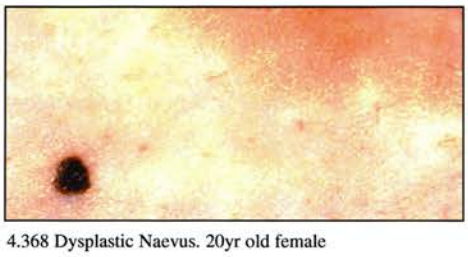
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.364 Periungual Fibroma. 41yr old female

4.365 Basal Cell Carcinoma. 55yr old female

4.366 Seborrhoeic Wart. 81yr old female

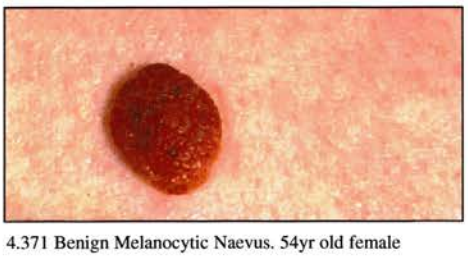
4.367 Benign Melanocytic Naevus. 48yr old male



4.368 Dysplastic Naevus. 20yr old female

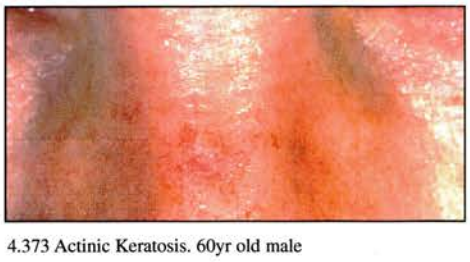
4.369 Adnexal Tumour. 79yr old female

4.370 Basal Cell Carcinoma. 56yr old male

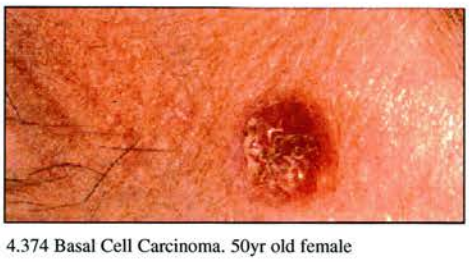


4.371 Benign Melanocytic Naevus. 54yr old female

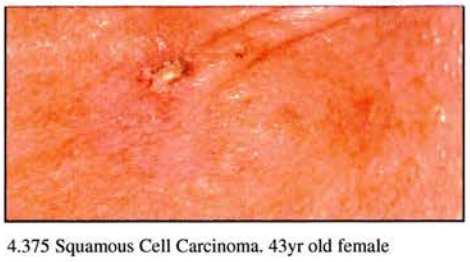
4.372 Bowen's Disease. 31yr old male



4.373 Actinic Keratosis. 60yr old male



4.374 Basal Cell Carcinoma. 50yr old female

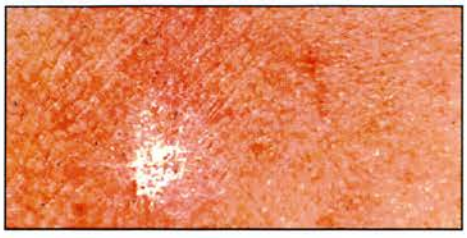


4.375 Squamous Cell Carcinoma. 43yr old female

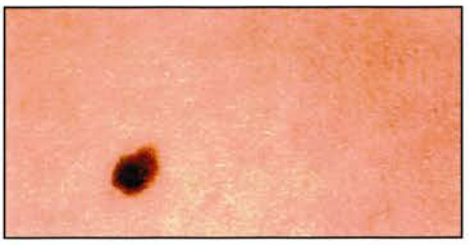
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.376 Basal Cell Carcinoma. 76yr old male

4.377 Benign Melanocytic Naevus. 34yr old male



4.378 Squamous Cell Carcinoma. 73yr old male



4.379 Dysplastic Naevus. 32yr old female

4.380 Benign Melanocytic Naevus. 34yr old male

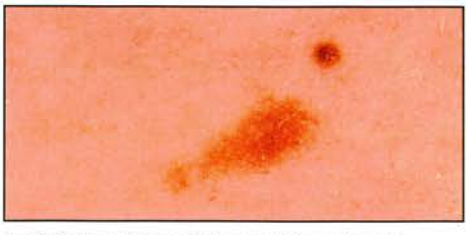
4.381 Benign Melanocytic Naevus. 41yr old male

4.382 Melanoma. 19yr old female

4.383 Actinic Keratosis. 93yr old female

4.384 Seborrhoeic Wart. 61yr old female

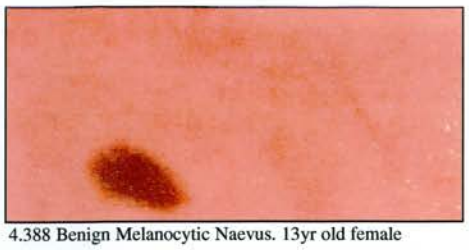
4.385 Basal Cell Carcinoma. 66yr old female



4.386 Benign Melanocytic Naevus. 26yr old female

4.387 Chondrodermatitis Nodularis Helicis. 81yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.



4.388 Benign Melanocytic Naevus. 13yr old female

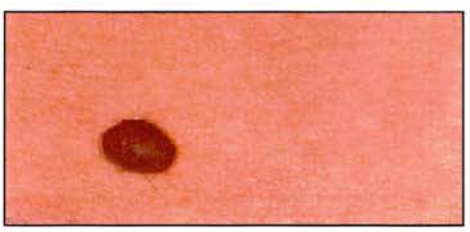
4.389 Basal Cell Carcinoma. 69yr old female

4.390 Seborrhoeic Wart. 89yr old female

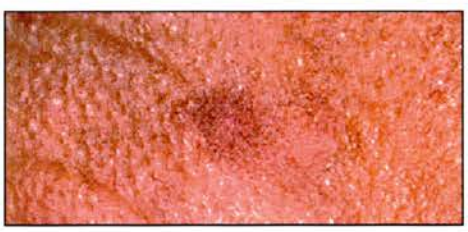
4.391 Squamous Cell Carcinoma. 59yr old female

4.392 Basal Cell Carcinoma. 53yr old male

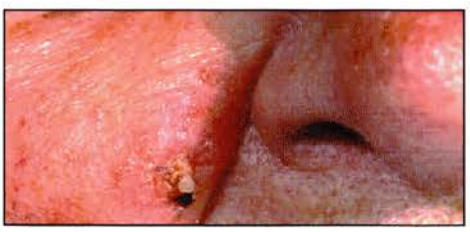
4.393 Dermatofibroma. 50yr old female



4.394 Benign Melanocytic Naevus. 33yr old female



4.395 Actinic Keratosis. 60yr old male



4.396 Basal Cell Carcinoma. 86yr old female

4.397 Basal Cell Carcinoma. 59yr old female

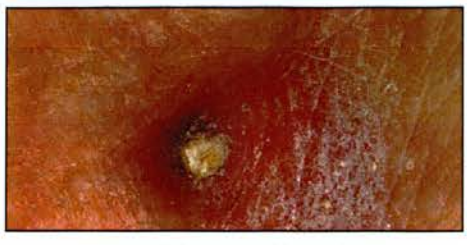
4.398 Bowen's Disease. 45yr old female

4.399 Eczema. 35yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

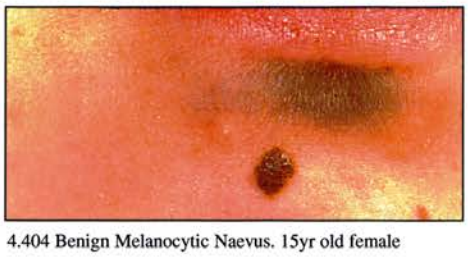
4.400 Bowen's Disease. 67yr old female

4.401 Benign Melanocytic Naevus. 25yr old female



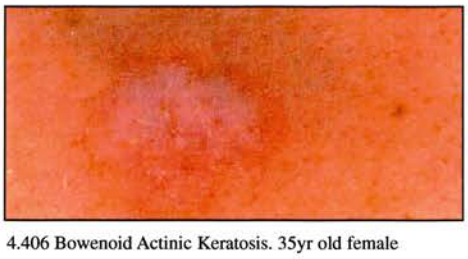
4.402 Squamous Cell Carcinoma. 66yr old female

4.403 Benign Melanocytic Naevus. 31yr old female



4.404 Benign Melanocytic Naevus. 15yr old female

4.405 Elastosis. 35yr old female

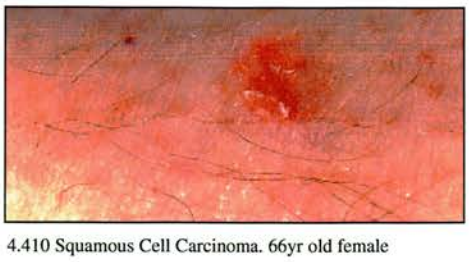


4.406 Bowenoid Actinic Keratosis. 35yr old female

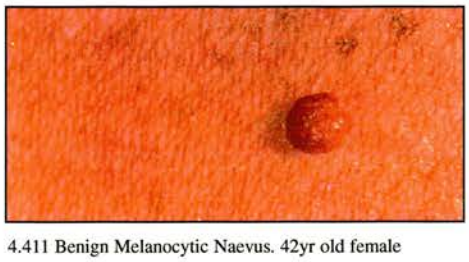
4.407 Actinic Keratosis. 73yr old male

4.408 Actinic Keratosis. 65yr old female

4.409 Benign Melanocytic Naevus. 23yr old female



4.410 Squamous Cell Carcinoma. 66yr old female



4.411 Benign Melanocytic Naevus. 42yr old female

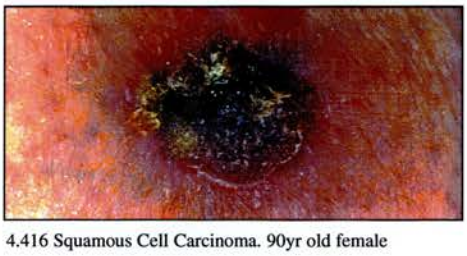
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.412 Melanoma. 82yr old male

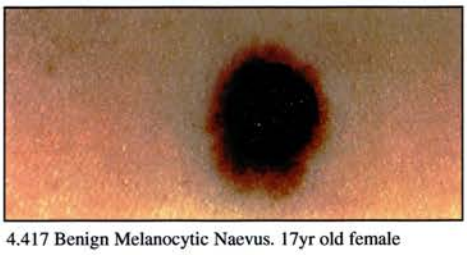
4.413 Seborrhoeic Wart. 60yr old male

4.414 Benign Melanocytic Naevus. 42yr old male

4.415 Squamous Cell Carcinoma. 76yr old female



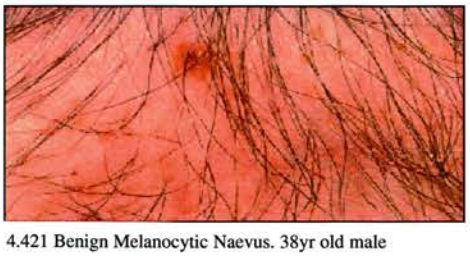
4.416 Squamous Cell Carcinoma. 90yr old female



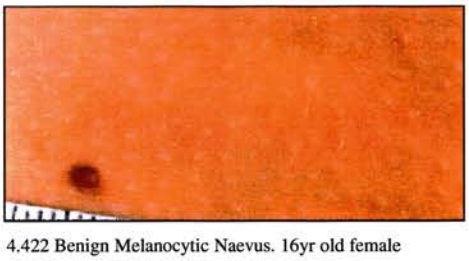
4.417 Benign Melanocytic Naevus. 17yr old female

4.418 Keratoacanthoma. 56yr old male

4.419 Bowen's Disease. 87yr old female



4.421 Benign Melanocytic Naevus. 38yr old male



4.422 Benign Melanocytic Naevus. 16yr old female

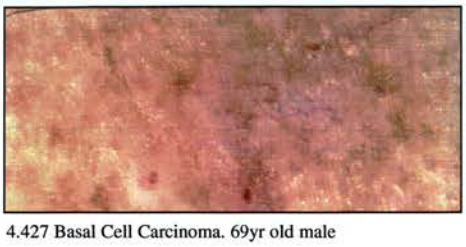
4.423 Actinic Keratosis. 60yr old male

4.424 Seborrhoeic Wart. 80yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.425 Basal Cell Carcinoma. 50yr old female

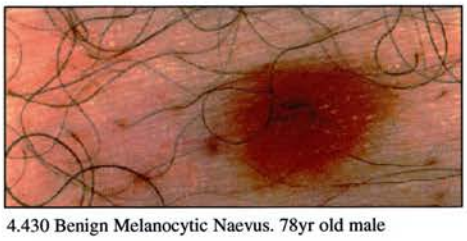
4.426 Squamous Cell Carcinoma. 54yr old male



4.427 Basal Cell Carcinoma. 69yr old male

4.428 Bowen's Disease. 68yr old male

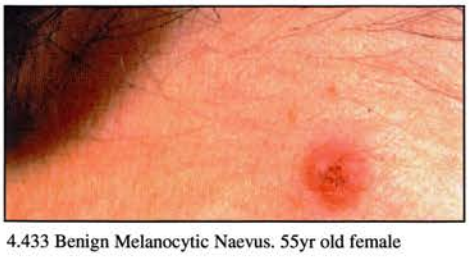
4.429 Squamous Cell Carcinoma. 58yr old female



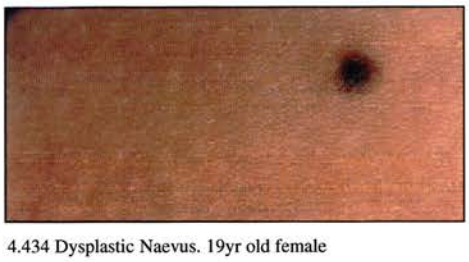
4.430 Benign Melanocytic Naevus. 78yr old male

4.431 Melanoma.65yr old male

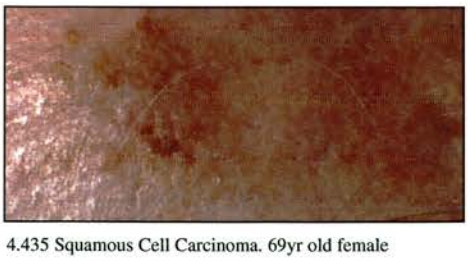
4.432 Basal Cell Carcinoma. 84yr old male



4.433 Benign Melanocytic Naevus. 55yr old female



4.434 Dysplastic Naevus. 19yr old female



4.435 Squamous Cell Carcinoma. 69yr old female

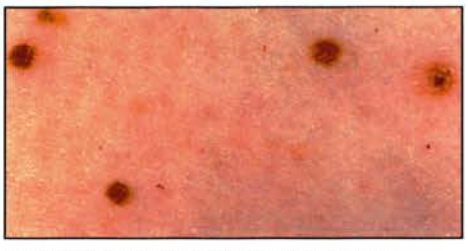
4.436 Actinic Keratosis. 69yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.437 Sebaceous Cyst. 59yr old female

4.438 Melanoma. 16yr old male

4.439 Seborrhoeic Wart. 55yr old male



4.440 Benign Melanocytic Naevus. 49yr old female

4.441 Seborrhoeic Warts. 78yr old female

4.442 Bowen's Disease. 77yr old female

4.443 Actinic Keratosis. 60yr old male

4.444 Non - specific. 67yr old female

4.445 Chondrodermatitis Nodularis Helicis. 90yr old female

4.446 Adnexal Tumour. 70yr old female

4.447 Dermatofibroma. 42yr old female

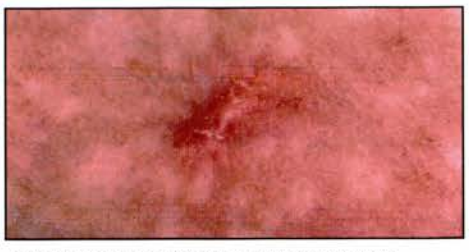
4.448 Benign Lentigo. 35yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

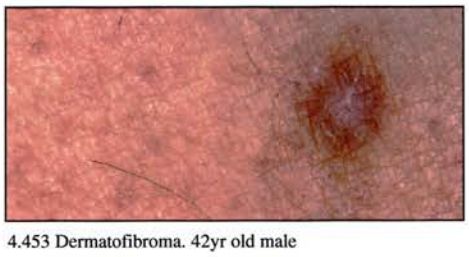
4.449 Benign Melanocytic Naevus.25yr old male

4.450 Benign Melanocytic Naevus. 25yr old male

4.451 Halo Naevus. 18yr old male

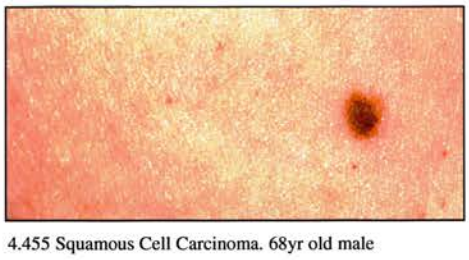


4.452 Squamous Cell Carcinoma. 55yr old female



4.453 Dermatofibroma. 42yr old male

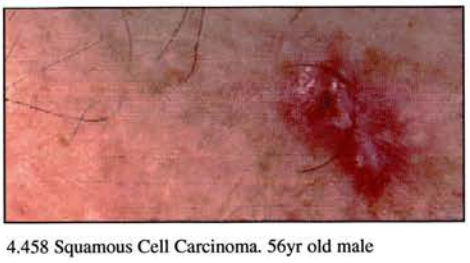
4.454 Actinic Keratosis. 56yr old female



4.455 Squamous Cell Carcinoma. 68yr old male

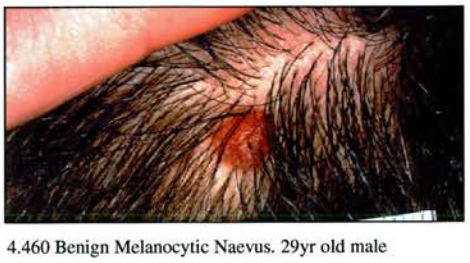
4.456 Squamous Cell Carcinoma. 79yr old female

4.457 Basal Cell Carcinoma. 88yr old female



4.458 Squamous Cell Carcinoma. 56yr old male

4.459 Squamous Papilloma. 62yr old male

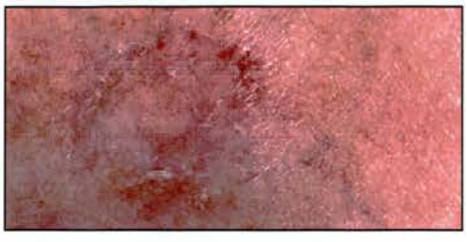


4.460 Benign Melanocytic Naevus. 29yr old male

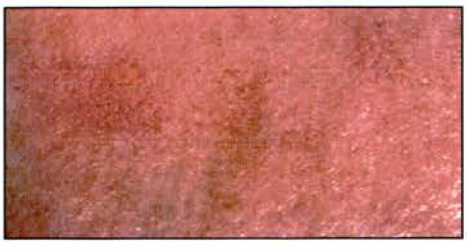
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.461 Benign Melanocytic Naevus. 73yr old male

4.462 Chrondrodermatitis Nodularis Helicis. 54yr old male

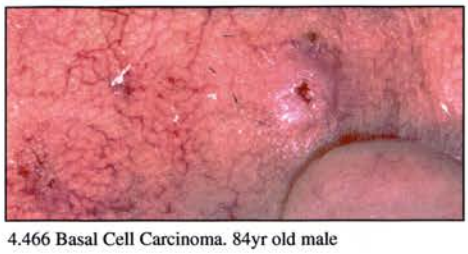


4.463 Basal Cell Carcinoma. 81yr old female



4.464 Actinic Keratosis. 58yr old female

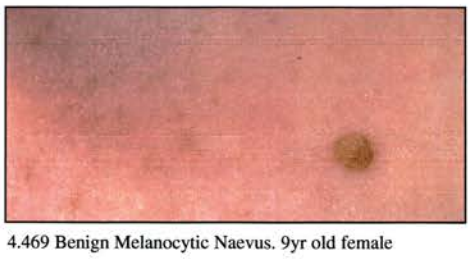
4.465 Non-specific. 67yr old female



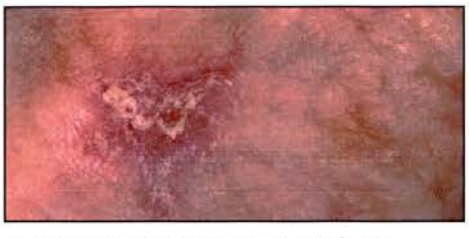
4.466 Basal Cell Carcinoma. 84yr old male

4.467 Bowen's Disease. 80yr old male

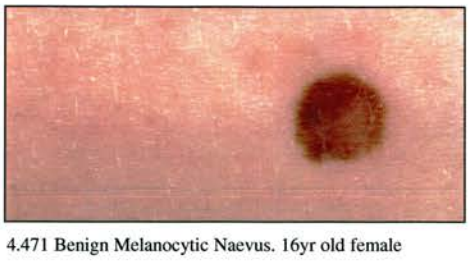
4.468 Bowens Disease. 69yr old female



4.469 Benign Melanocytic Naevus. 9yr old female



4.470 Squamous Cell Carcinoma. 76yr old female



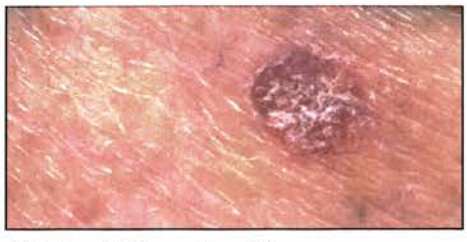
4.471 Benign Melanocytic Naevus. 16yr old female

4.472 Benign Melanocytic Naevus. 16yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.473 Viral Wart. 5yr old female

4.474 Seborrhoeic Wart. 37yr old male



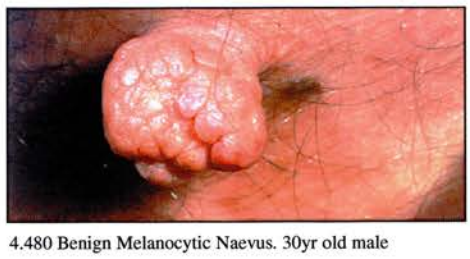
4.475 Bowen's Disease. 87yr old female

4.476 Squamous Cell Carcinoma. 87yr old male

4.477 Squamous Cell Carcinoma. 86yr old male

4.478 Actinic Keratosis. 83yr old female

4.479 Haemangioma. 31yr old female



4.480 Benign Melanocytic Naevus. 30yr old male

4.481 Pyogenic Granuloma. 4yr old male

4.482 Squamous Cell Carcinoma. 53yr old male

4.483 Viral Wart. 15yr old female

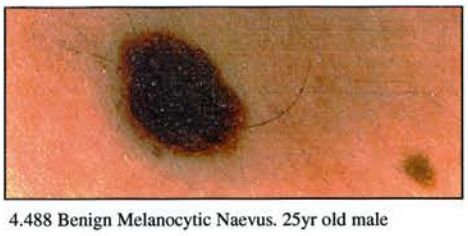
4.484 Basal Cell Carcinoma. 76yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.485 Dermatofibroma. 42yr old female

4.486 Seborrhoeic Wart. 63yr old female

4.487 Benign Melanocytic Naevus. 57yr old female



4.488 Benign Melanocytic Naevus. 25yr old male

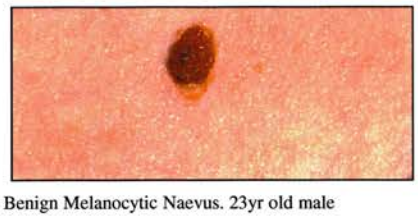
4.489 Basal Cell Carcinoma. 66yr old female

4.490 Irritated Seborrhoeic Wart. 67yr old female

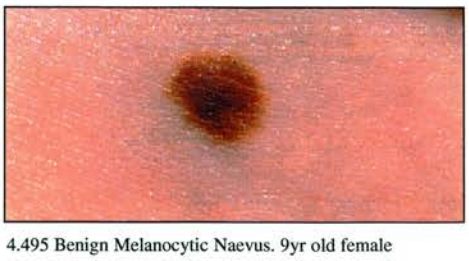
4.491 Squamous Cell Carcinoma. 73yr old female

4.492 Basal Cell Carcinoma. 58yr old male

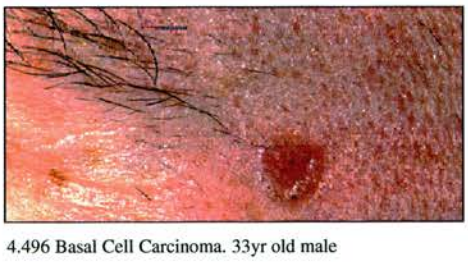
4.493 Squamous Cell Carcinoma. 89yr old female



4.494 Benign Melanocytic Naevus. 23yr old male



4.495 Benign Melanocytic Naevus. 9yr old female



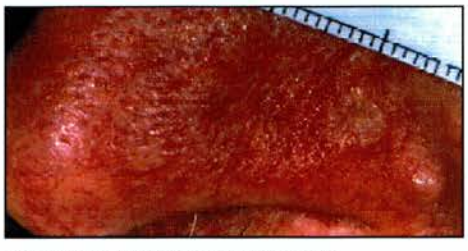
4.496 Basal Cell Carcinoma. 33yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

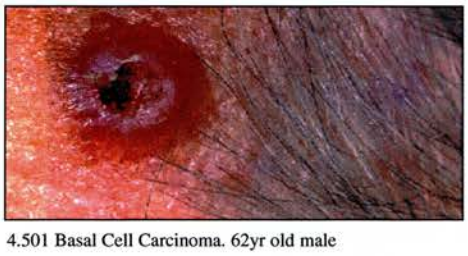
4.497 Dysplastic Naevus. 44yr old male

4.498 Benign Melanocytic Naevus. 2yr old female

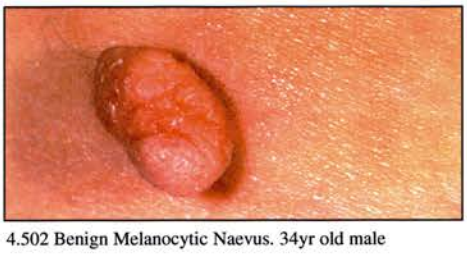
4.499 Benign Melanocytic Naevus. 32yr old female



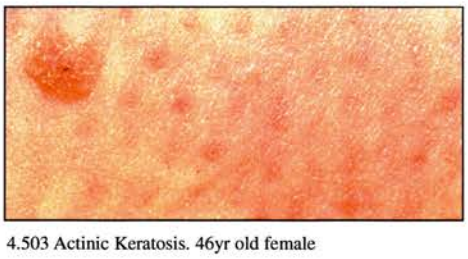
4.500 Basal Cell Carcinoma. 57yr old male



4.501 Basal Cell Carcinoma. 62yr old male



4.502 Benign Melanocytic Naevus. 34yr old male



4.503 Actinic Keratosis. 46yr old female

4.504 Non-specific. 53yr old female

4.505 Basal Cell Carcinoma. 72yr old female

4.506 Melanoma. 56yr old male

4.507 Pyogenic Granuloma. 37yr old female

4.508 Squamous Cell Carcinoma. 59yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.509 Benign Melanocytic Naevus. 28yr old female

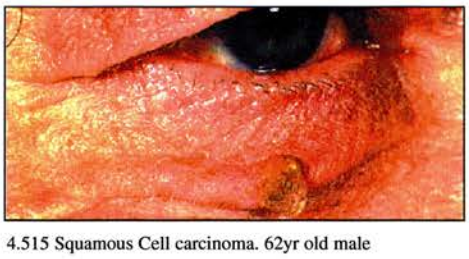
4.510 Benign Melanocytic Naevus. 33yr old female

4.511 Benign Melanocytic Naevus. 48yr old male

4.512 Seborrhoeic Wart. 74yr old female

4.513 Seborrhoeic Wart. 61yr old female

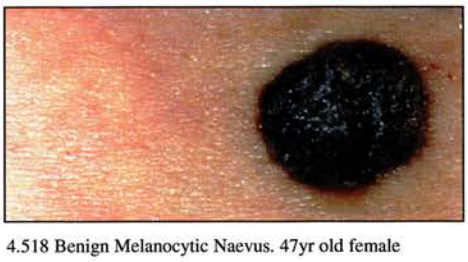
4.514 Squamous Cell Carcinoma. 69yr old male



4.515 Squamous Cell carcinoma. 62yr old male

4.516 Actinic Keratosis. 59yr old male

4.517 Benign Melanocytic Naevus. 67yr old female



4.518 Benign Melanocytic Naevus. 47yr old female

4.519 Keloid. 55yr old female

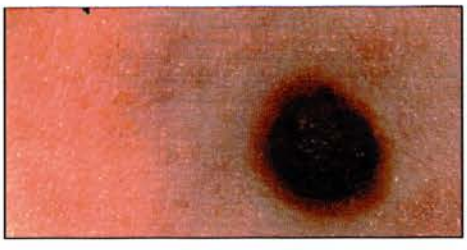
4.520 Adnexal Tumour. 50yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.521 Benign Melanocytic Naevus. 19yr old male

4.522 Benign Melanocytic Naevus. 9yr old male

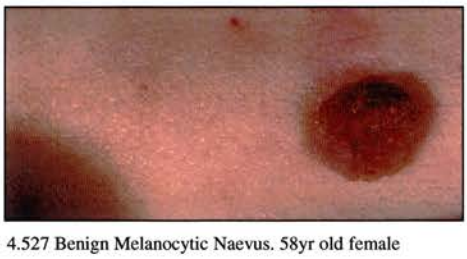
4.523 Epidermal Naevus. 36yr old female



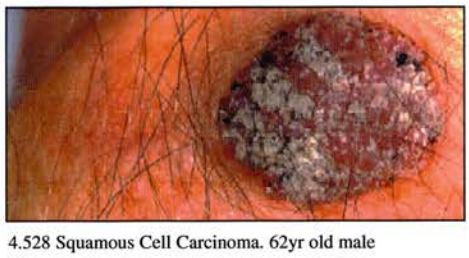
4.524 Benign Melanocytic Naevus. 16yr old female

4.525 Radionecrosis. 74yr old female

4.526 Basal Cell Carcinoma. 79yr old female



4.527 Benign Melanocytic Naevus. 58yr old female



4.528 Squamous Cell Carcinoma. 62yr old male

4.529 Squamous Cell Carcinoma. 94yr old female

4.530 Benign Melanocytic Naevus. 32yr old female

4.531 Non - specific. 76yr old male

4.532 Actinic Keratosis. 90yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

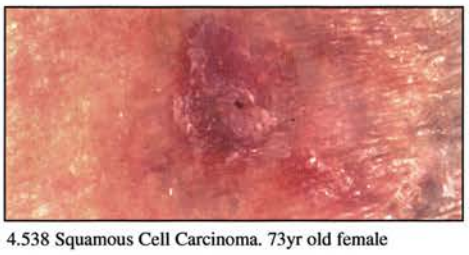
4.533 Squamous Cell Carcinoma. 73yr old female

4.534 Benign Melanocytic Naevus. 73yr old male

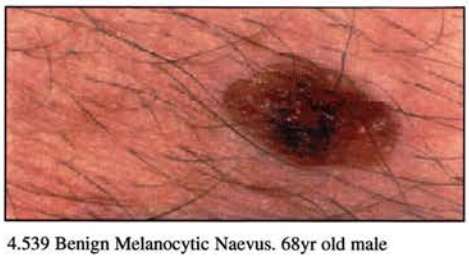
4.535 Benign Melanocytic Naevus. 34yr old female

4.536 Squamous Cell Carcinoma. 75yr old female

4.537 Actinic Keratosis. 65yr old female

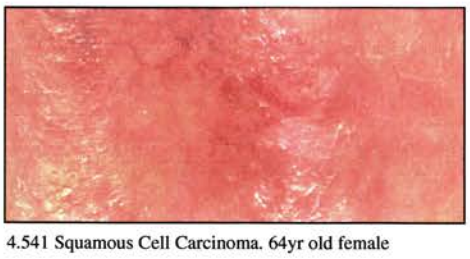


4.538 Squamous Cell Carcinoma. 73yr old female



4.539 Benign Melanocytic Naevus. 68yr old male

4.540 Benign Melanocytic Naevus. 28yr old female



4.541 Squamous Cell Carcinoma. 64yr old female

4.542 Bowen's Disease. 66yr old female

4.543 Keloid. 33yr old female

4.544 Pyogenic Granuloma. 31yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.545 Sebaceous Hyperplasia. 44yr old male

4.546 Benign Melanocytic Naevus. 13yr old female

4.547 Benign Melanocytic Naevus. 9yr old female

4.548 Squamous Cell Carcinoma. 70yr old male

4.549 Squamous Cell Carcinoma. 5yr old female

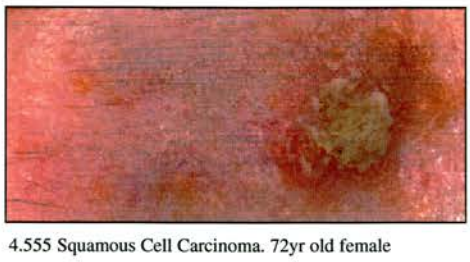
4.550 Benign Melanocytic Naevus. 43yr old female

4.551 Bowen's Disease. 81yr old female

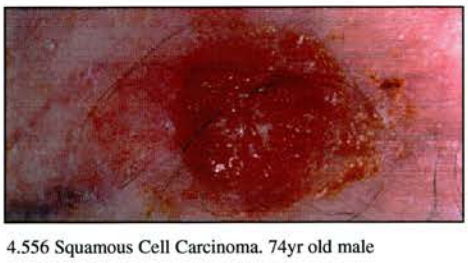
4.552 Seborrhoeic Wart . 80yr old female

4.553 Seborrhoeic Wart. 82yr old female

4.554 Squamous Cell Carcinoma. 87yr old male

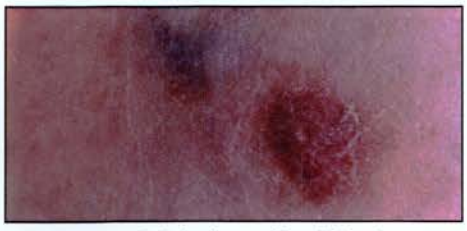


4.555 Squamous Cell Carcinoma. 72yr old female

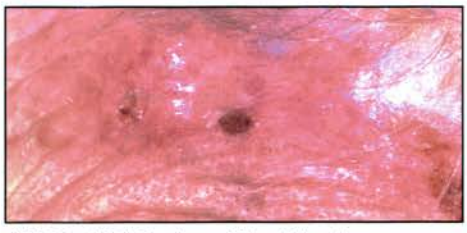


4.556 Squamous Cell Carcinoma. 74yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.



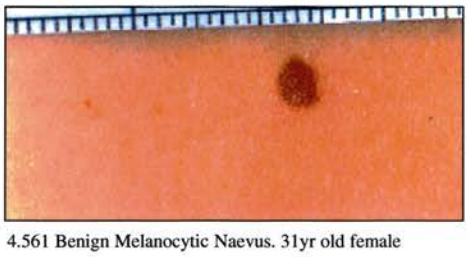
4.557 Squamous Cell Carcinoma. 60yr old female



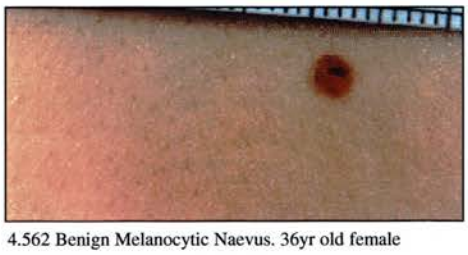
4.558 Basal Cell Carcinoma. 94yr old female

4.559 Benign Melanocytic Naevus. 28yr old female

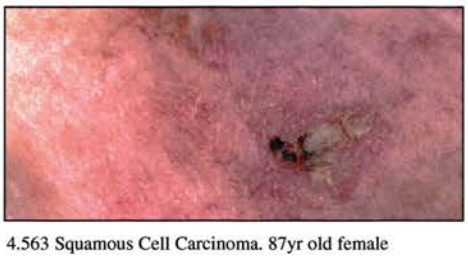
4.560 Seborrhoeic Wart. 46yr old male



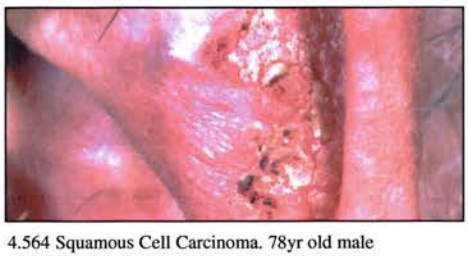
4.561 Benign Melanocytic Naevus. 31yr old female



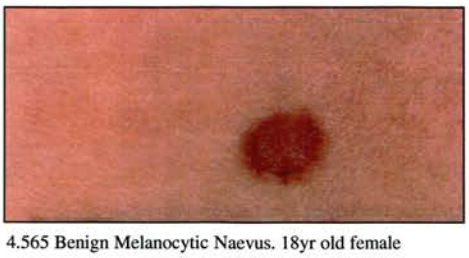
4.562 Benign Melanocytic Naevus. 36yr old female



4.563 Squamous Cell Carcinoma. 87yr old female



4.564 Squamous Cell Carcinoma. 78yr old male



4.565 Benign Melanocytic Naevus. 18yr old female

4.566 Benign Lentigo. 65yr old female

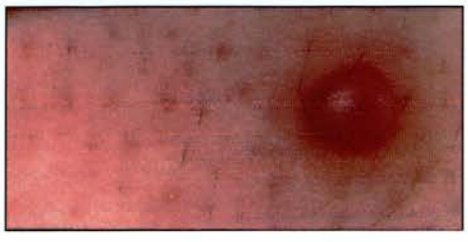
4.567 Keloid. 18yr old male

4.568 Seborrhoeic Warts. 53yr old female

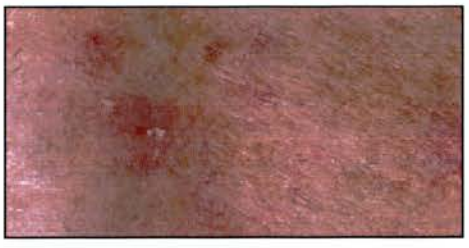
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.569 Seborrhoeic Wart. 61yr old female

4.570 Scar. 21yr old female

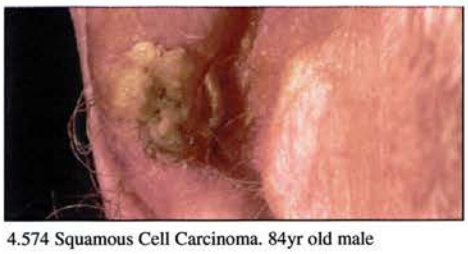


4.571 Benign Melanocytic Naevus. 39yr old female



4.572 Actinic Keratosis. 73yr old male

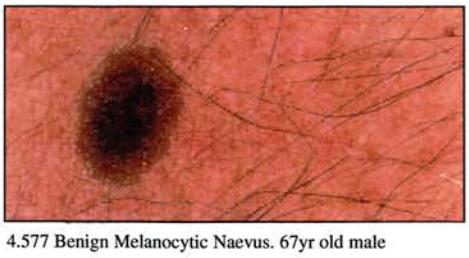
4.573 Seborrhoeic Wart. 72yr old female



4.574 Squamous Cell Carcinoma. 84yr old male

4.575 Basal Cell Carcinoma. 87yr old female

4.576 Squamous Cell Carcinoma. 88yr old female



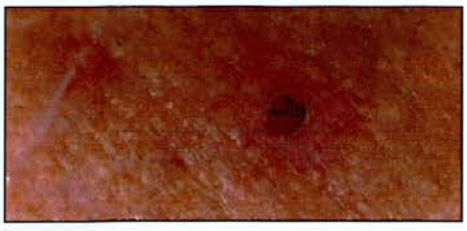
4.577 Benign Melanocytic Naevus. 67yr old male

4.578 Benign Melanocytic Naevus. 68yr old male

4.579 Squamous Cell Carcinoma. 75yr old male

4.580 Basal Cell Carcinoma. 72yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.



4.581 Benign Melanocytic Naevus. 74yr old male

4.582 Bowen's Disease. 77yr old female

4.583 Squamous Cell Carcinoma. 89yr old male

4.584 Squamous Cell Carcinoma. 55yr old male

4.585 Benign Melanocytic Naevus. 26yr old female

4.586 Actinic Keratosis. 51yr old female

4.587 Haemangioma. 85yr old male

4.588 Basal Cell Carcinoma. 65yr old female

4.589 Basal Cell Carcinoma. 81yr old female

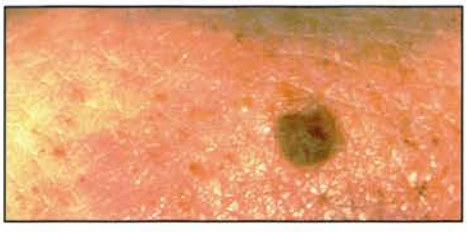
4.590 Bowen's Disease. 77yr old male

4.591 Basal Cell Carcinoma. 87yr old male

4.592 Pyogenic Granuloma. 53yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

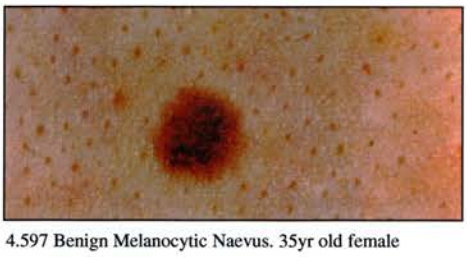
4.593 Squamous Cell Carcinoma. 65yr old male



4.594 Seborrhoeic Wart. 69yr old male

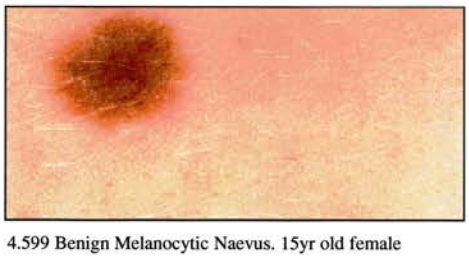
4.595 Seborrhoeic Wart. 86yr old male

4.596 Benign Melanocytic Naevus. 15yr old female



4.597 Benign Melanocytic Naevus. 35yr old female

4.598 Actinic Keratosis. 69yr old female

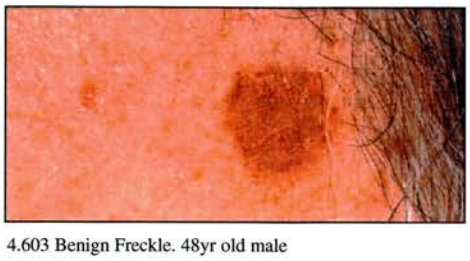


4.599 Benign Melanocytic Naevus. 15yr old female

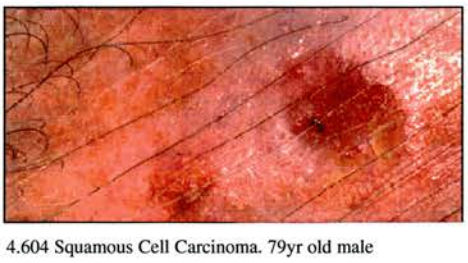
4.600 Pigmented Dermatofibroma. 16yr old female

4.601 Basal Cell Carcinoma. 66yr old female

4.602 Actinic Keratosis. 71yr old male



4.603 Benign Freckle. 48yr old male



4.604 Squamous Cell Carcinoma. 79yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.605 Basal Cell Carcinoma. 64yr old female

4.606 Squamous Cell Carcinoma. 85yr old female

4.607 Basal Cell Carcinoma. 84yr old male

4.608 Benign Melanocytic Naevus. 27yr old female

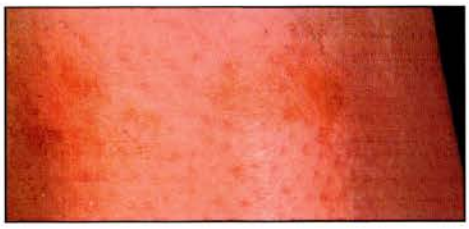
4.609 Basal Cell Carcinoma. 48yr old male

4.610 Dysplastic Naevus. 14yr old male

4.611 Benign Melanocytic Naevus. 51yr old female

4.612 Benign Melanocytic Naevus. 24yr old female

4.613 Basal Cell Carcinoma. 93yr old female



4.614 Benign Lentigo. 36yr old female

4.615 Bowen's Disease. 52yr old female

4.616 Actinic Keratosis. 66yr old female

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.617 Dysplastic Naevus. 46yr old male

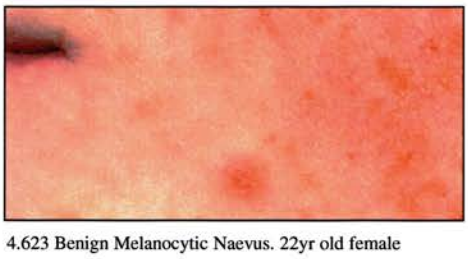
4.618 Basal Cell Carcinoma. 56yr old male

4.619 Squamous Cell Carcinoma. 66yr old male

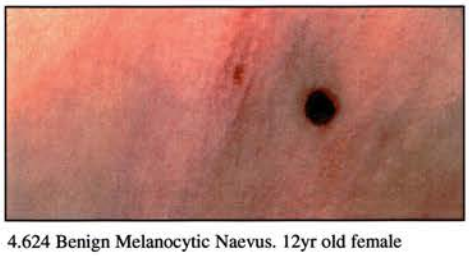
4.620 Basal Cell Carcinoma. 58yr old female

4.621 Basal Cell Carcinoma. 62yr old male

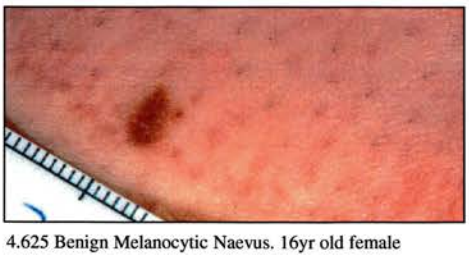
4.622 Keloid. 36yr old female



4.623 Benign Melanocytic Naevus. 22yr old female

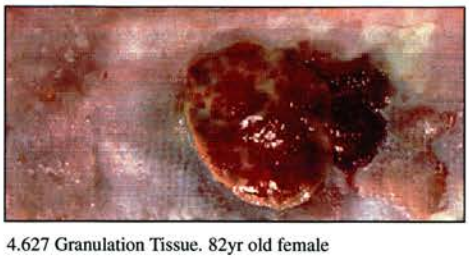


4.624 Benign Melanocytic Naevus. 12yr old female

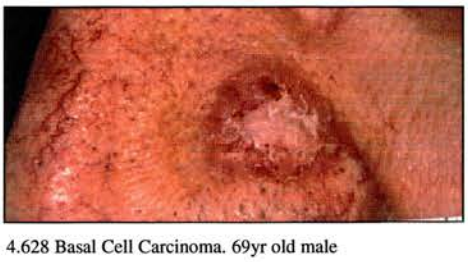


4.625 Benign Melanocytic Naevus. 16yr old female

4.626 Benign Lentigo. 37yr old female



4.627 Granulation Tissue. 82yr old female



4.628 Basal Cell Carcinoma. 69yr old male

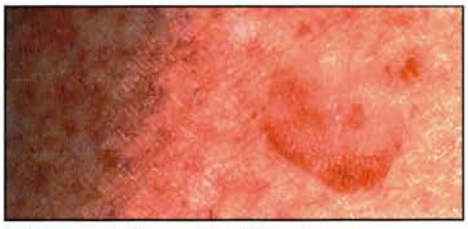
Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

4.629 Benign Melanocytic Naevus. 55yr old female

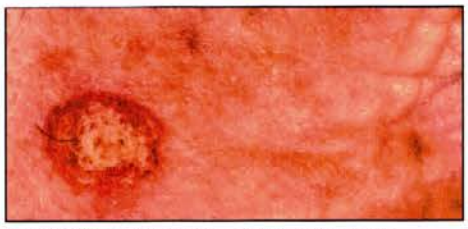
4.630 Seborrhoeic Wart. 80yr old female

4.631 Seborrhoeic Wart. 70yr old male

4.632 Squamous Cell Carcinoma. 56yr old female

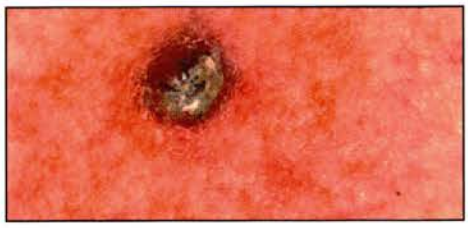


4.633 Bowen's Disease. 54yr old female



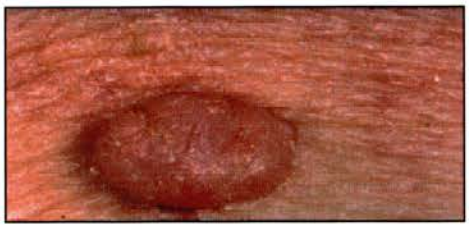
4.634 Squamous Cell Carcinoma. 86yr old female

4.635 Squamous Cell Carcinoma. 55yr old female

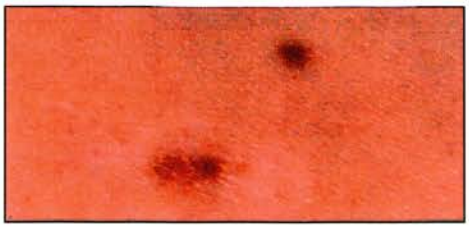


4.636 Squamous Cell Carcinoma. 87yr old female

4.637 Chondrodermatitis Nodularis Helicis . 44yr old male



4.638 Benign Melanocytic Naevus. 63yr old female



4.639 Benign Melanocytic Naevus. 33yr old female

4.640 Benign Melanocytic Naevus. 28yr old male

Conventional photography in the management of dermatology patients with skin tumours in Morecambe Bay. Study 4.

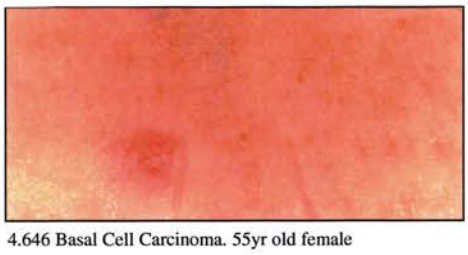
4.641 Basal Cell Carcinoma. 50yr old male

4.642 Benign Melanocytic Naevus. 44yr old female

4.643 Squamous Cell Carcinoma. 70yr old female

4.644 Actinic Keratosis. 74yr old female

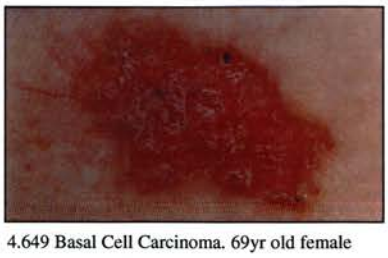
4.645 Basal Cell Carcinoma. 65yr old female



4.646 Basal Cell Carcinoma. 55yr old female

4.647 Benign Melanocytic Naevus. 62yr old female

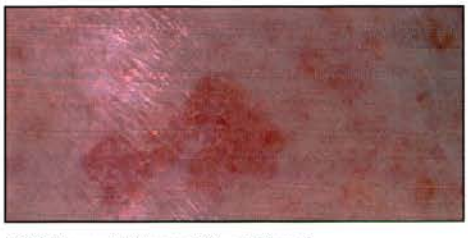
4.648 Molluscum Contagiosum. 35yr old female



4.649 Basal Cell Carcinoma. 69yr old female

4.650 Benign Melanocytic Naevus. 16yr old female

4.651 Viral Wart. 19yr old male



4.652 Bowen's Disease. 70yr old female

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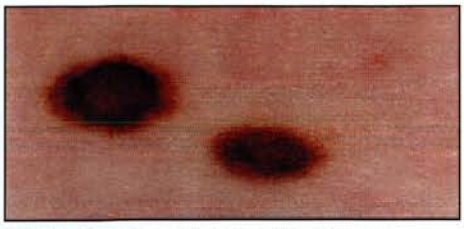


4.653 Benign melanocytic naevus. 33yr old female

4.654 Spider Naevus. 8yr old female

4.655 Benign melanocytic naevus. 51yr old female

4.656 Seborrhoeic Wart. 65yr old female

Out of 656 patients having photographic assessment, a total of 574 patients completed treatment, with removal of skin tumours, enabling histological assessment of the problem. Therefore, 12.5% of patients did not have operative procedures. Of these, most (69%) were seen for review in clinics for face-to-face consultation in order to reassess the diagnosis, but some were also reviewed because of inadequate photographic detail to competently ascertain the diagnosis. A few patients (1%) were referred back to the general practitioner from without clinical review, the conditions having cleared or the problem being confidently benign with no action being necessary. By the very nature of that most of the patients had skin tumours, most had dermatological procedures which usually involve excision of a skin lesion. All skin operations where necessary were performed in the dermatology units at either Lancaster, Kendal or Barrow.

Rather than analyse all the patients simultaneously who eventually had operative treatment, it was convenient to assess 3 separate cohorts of patients completing treatment. This allowed an assessment of whether the diagnostic accuracy was remaining consistent. As well as assessment of diagnostic accuracy, the different tumour types were analysed in the first and third group of patients, tumour sites in the second, and benign/maglignant accuracy plus treatment prediction in the second and third group of patients.

Analysis of data on the first 200 patients completing treatment revealed the diagnostic accuracy of photographic assessment to be 71% (95% confidence

interval 64%-77%). Analysis on a further 210 patients showed a mixture of skin tumour types (table 17), with benign melanocytic naevus being the commonest skin tumour, followed by basal cell carcinoma and actinic keratosis (histological diagnosis):

Table 17
Skin tumour types.

Diagnosis	General Practitioner diagnosis	Photographic diagnosis	Histological diagnosis
Basal cell carcinoma	36	34	33
Non-specific	43	4	7
Seborrhoeic wart	14	19	26
Actinic keratosis	17	19	27
Squamous cell carcinoma	14	32	20
Bowen's disease	8	15	9
Benign melanocytic naevus	36	41	40
Melanoma	3	4	4
Sebaceous cyst	6	6	7
Lichen planus	0	0	1
Wart	8	5	7
Pyogenic granuloma	2	3	3
Haemangioma	3	1	2
Squamous papilloma	0	5	4
Dermatofibroma	5	7	6
Chondrodermatitus nodularis helicis	2	4	4
Fibroepitheliomatous polyp	2	1	2
Dysplastic naevus	3	5	3
Benign lentigo	4	3	2
Keratoacanthoma	4	2	2
Adnexal tumour	0	0	1
TOTAL	210	210	210

Table 18 shows the different skin tumour sites in 210 patients:

Table 18
Skin tumour sites.

Site	No.	Site	No.
Cheek	31	Hand/Fingers	12
Forehead/Temples	25	Neck	8
Leg	21	Scalp	14
Back	18	Lip	4
Nose	16	Chin	10
Ear	9	Eyebrow	5
Arm/Shoulder	14	Foot	6
Chest/Breast	17		
TOTAL	210		

Analysis of the second group of patients completing treatment indicated that photographic assessment was able to detect skin malignancy accurately in 94% of patients (95% confidence interval 90%-97%). Furthermore, photographic assessment was able to predict appropriate therapy in 94% of patients (95% confidence interval 90-97%). Table 19 shows the actual treatment carried out on the patient and the treatment recommendation by photographic assessment:

Table 19
Treatment recommended by photographic assessment, and actual treatment subsequently undertaken on skin tumours.

	Recommended	Actual
Curettage and cautery	116	108
Shave excision	64	53
Delineated excision	10	10
Elliptical excision	6	18
Punch biopsy	4	4
Enucleation	2	2
Clinical review with No treatment	8	15
TOTAL	210	210

Data analysis on the last 164 patients who had completed treatment showed the diagnostic accuracy to be 75% (95% confidence interval 68%-81%). In this group of patients there were 97 females and 67 males - age range 8 yrs to 96 yrs, mean 55 years. Comparison of different diagnoses from photographic and histological assessment (whether or not there was agreement) is shown in Appendix 2, and this also shows the number of different diagnoses by general practitioner and for some diagnoses, for example seborrhoeic wart and squamous cell carcinoma, there was a difference between the general practitioner assessment and either photographic or histological assessment. The number of patients having different diagnoses, either photographic or histological, is shown in Table 20:

Table 20
Assessment of conventional photography in Morecambe Bay.
Diagnostic groupings.

Photographic Diagnosis		Histological Diagnosis	
Actinic keratosis	18	Actinic keratosis	24
Basal cell carcinoma	33	Basal cell carcinoma	32
Benign melanocytic naevus	32	Benign melanocytic naevus	30
Seborrhoeic wart	18	Seborrhoeic wart	25
Actinic keratosis	18	Actinic keratosis	24
Squamous cell carcinoma	12	Squamous cell carcinoma	12
Sebaceous cyst	1	Sebaceous cyst	1
Haemangioma	2	Haemangioma	2
Blue naevus	1	Blue naevus	0
Solar elastosis	0	Solar elastosis	2
Adnexal tumour	4	Adnexal tumour	3
Squamous papilloma	2	Squamous papilloma/viral wart	3
Chondrodermatitis nodularis helicis	1	Chondrodermatitis nodularis helicis	0
Dermatofibroma	2	Dermatofibroma	3
Bowen's disease	7	Bowen's disease	6
Melanoma	2	Melanoma	2
Non-specific	8	Non-specific	3
Epidermal naevus	0	Epidermal naevus	1
Freckle	2	Freckle	0
Pyogenic granuloma	0	Pyogenic granuloma	1
Lichen simplex	1	Lichen simplex	0
TOTAL	164	TOTAL	164

In this last group of 164 patients, photographic assessment was able to determine whether a skin lesion was benign or malignant in 93% of cases (95% confidence interval 88%-97%). In only two patients was there a disagreement between the photographic diagnosis and the final diagnosis which was potentially of clinical significance. One patient had a skin lesion diagnosed photographically as granulation tissue, but a squamous cell carcinoma was later found histologically. The other patient had a skin lesion diagnosed by photograph assessment as a benign adnexal tumour, but histologically it was found to be a basal cell carcinoma. In 91% of patients (95% confidence interval 86%-95%), the treatment recommended by photographic assessment was satisfactory. In only 9% of patients was treatment recommended by photographic assessment inappropriate, but in no patient was it detrimental.

All patients with significant skin tumours such as melanoma were successfully diagnosed photographically. Furthermore, during the study period, dermatology waiting lists were reduced by over 75% across the three hospital sites (reducing in one hospital from eight months to one month during the six months of the study).

4.1.4 Discussion

The diagnostic accuracy in this study was consistent and averaged 73%, comparing favourably with the previous studies 1 and 3. However, even though this accuracy may be less than that achievable in a clinic situation (80%-85%), the method could effectively be used for patient triaging (thereby helping with waiting list priorities) since the assessment of photographs could accurately determine whether or not a tumour was benign or malignant in up to 94% of patients. Of practical relevance, photographic assessment of skin tumours enabled the prediction of appropriate treatment in a high percentage of the patients in this study (91%-94%, mean 92%).

The high number of patients receiving operative treatment (87.5%) reflected the need to ascertain the diagnostic accuracy by histological analysis of skin lesions from patients within the study, but also partly was related to the fact that most skin tumours referred for assessment may require skin surgery – either prompted by medical assessment by a general practitioner or initiated by the patient. A criticism sometimes raised against telemedicine is that a patient may be denied the assessment of other skin problems, but in the present study a relatively high

percentage of patients (upto 35%) had more than one skin lesion photographed – either at the discretion of the medical photographer or initiated by the patient. The medical photographer had been briefed by the dermatologist to photograph other skin lesions, either those looking unusual or suspicious - or if the patient expressed concerns over additional skin lesions.

During the study, waiting lists were reduced in the three hospital sites (by 75%), and this was mostly attributable to photographic clinics. Furthermore, it was apparent that the diagnostic accuracy of photographic assessment of skin tumours was higher than that achieved by the referring general practitioners prior to patient referral. Thus, providing that photographic images were of sufficient quality and resolution, teledermatology in a still image-based system using a store-and-forward mode, could be used for the triaging of patients on waiting lists - thereby useful as a waiting list management tool.

In a previous study (study 2), patient views on the possible use of photographs for skin problems had been sought, and most viewed skin imaging favourably as a method of skin assessment. However, patients actually recieving photographic assessment had not yet been assessed on their views on image assessment. Therefore, the next study was designed to seek patient views, and if conventional photographic imaging was found acceptable, this could then be extrapolated to digital imaging, thereby achieving true telemedcine.

4.2 Study 5. Patient Assessment.

4.2.1 Introduction

Would photographic assessment of skin tumours be acceptable to patients? In an earlier pilot study (study 2), a visual analogue scale had been used to assess whether photographs being used to assess skin lesions would be acceptable. Questionnaires had been issued to 100 patients, and 94% of patients completing the analogue scale thought that interpretation of skin lesions by photography could be used as an alternative to standard clinic appointments. But this was not testing an actual service, and in the last study (study 4) there had been 656 patients

assessed by conventional photography. A questionnaire was designed (appendix 3) to assess patients views on photographic assessment of their skin problem.

4.2.2 Methods

Questionnaires were issued to patients when they attended for conventional imaging at either Lancaster, Kendal or Barrow. Alternate patients, attending the photographic sessions, were asked to complete questionnaires (appendix 3). A number of patients also completed questionnaires after they had received treatment consequent upon imaging assessment (appendix 5).

4.2.3 Results

The patient satisfaction questionnaires were completed by 291 patients, age range 1yr - 94yrs, mean 51.7yrs. There were 194 females and 97 males, with 157 patients from Lancaster, 64 patients from Kendal, 52 patients from Barrow. The results of the patient questionnaire are shown in appendix 4 and summarised on Table 21:

Table 21
Result of pre-treatment patient questionnaire.

	Yes	No	No Opinion
Preferred to be seen in clinic rather than photographic imaging	14%	42%	44%
Preferred to be managed by photographic imaging rather than attending clinic	40%	19%	41%
Found the photography service preferable to clinics	78%	16%	6%
Satisfied with photographic service	85%	7%	8%

The questionnaire results indicated that patients did usually find dermatological management by still photographic imaging acceptable, and 85% of patients were satisfied with the photographic service (95% confidence limit 80%-89%). In addition, 78% of patients found the photographic imaging service preferable to attendance at standard dermatology clinics (95% confidence limit 73%-83%). Only 14% of patients expressed a preference to be seen in the dermatology clinic rather than attendance at an imaging clinic (95% confidence limit 10-19%).

After skin surgery and removal of skin tumours, 49 patients completed a post-treatment questionnaire and a summary of the results is shown in Table 22:

Table 22
Result of post-treatment patient questionnaire.

100%	satisfied with treatment following photographic assessment.
89%	satisfied with management plan following photographic assessment.
83%	received a management plan quickly enough after the photographic assessment.
96%	happy to attend photographic imaging sessions again if necessary.
95%	described imaging service as helpful and efficient.
3%	not satisfied with imaging service, being inferior to attending traditional hospital clinics

100% of the patients completing the post-treatment questionnaire were satisfied with their treatment following photographic assessment, and 96% were happy to attend photographic imaging sessions again if necessary, with only 3% of patients not being satisfied with skin assessment by imaging.

4.2.4 Discussion

This study showed that a high percentage of patients indicated satisfaction with skin assessment by photographic imaging. There were differences between patient responses before tumour removal and after treatment. Before treatment, 85% of patients answering questionnaires indicated satisfaction with photographic imaging, whereas after treatment this had risen to 100% of patients. Also, before treatment, 14% of patients said they would prefer to be seen in the clinic rather than attending imaging clinics, whereas after treatment this had reduced to 3% of patients not being satisfied with the imaging service as compared to attending hospital clinics. This would indicate that some patients, who perhaps initially expressed anxieties about the service, improved their views after satisfactory treatment.

4.3 Study 6. General Practitioner Assessment

4.3.1 Introduction

Having established patient acceptance of still photographic imaging for dermatological management, was it acceptable to general practitioners? The views of some of the referring general practitioners were sought by a questionnaire approach.

4.3.2 Methods

After patients had completed photographic assessment and treatment, questionnaires were sent to some of the referring general practitioners. A questionnaire was designed (appendix 6), which sought general practioner views on the imaging service and general practitioners (of every 5^{th} patient attending for the skin imaging) were sent questionnaires.

4.3.3 Results

Questionnaires were sent to 75 general practitioners in the Morecambe Bay area (who referred patients included in the study). Questionnaires were returned from 49 general practitioners and these were available for analysis, the results being shown in Appendix 7.

Most general practitioners (89% - 95% confidence limit 75%-95%) were satisfied with the length of time, from referral of the patient, before being assessed by the photographic clinic. Most general practitioners (82%) were also satisfied with the length of time between the photographic assessment and the treatment for the skin lesion. The majority of general practitioners indicated sufficient information was given concerning the diagnosis (88%) and the planned treatment (84%) in the letter sent after photographic assessment. Some general practitioners, however, described minor problems with the photographic approach (33%) but these were mostly encountered during the early stages of the study. The majority of criticisms were related to paperwork issues, but these lessened as the study progressed over the 6 months. No general practitioner expressed concerns on medical issues such as diagnostic accuracy, or treatment recommendations. However, some general practitioners (22%) did express concerns over confidentiality, if digital technology was to be used. Some general practices, possibly more technologically sympathetic, were happier with the service than others. The age or experience of general practioners were not examined in realtionship to questionnaire responses.

4.3.4 Discussion

A high percentage of general practitioners were satisfied with aspects of the photographic service, although some did express reservations. Minor problems included delays in letters, and occasional inadequate reassurance offered to patients who had not attended hospital clinics.

There was an overall favourable response, although some general practitioners seemed less reluctant to accept imaging as a method of skin assessment. Patient satisfaction appeared higher in Study 5, than general practitioner acceptance of photographic imaging in the present study. This may have implications for future planning in the delivery of service.

So far, the work has been examining conventional photographic imaging, but for true telemedicine digital imaging is largely more suitable and therefore the next studies (7, 8 and 9) examines digital imaging and the suitability of digital images for dermatological patient assessment.

CHAPTER 5

PILOT DIGITAL IMAGE STUDIES

5.1 Study 7. Digital Pilot Study A : A portable imaging system

5.1.1 Introduction

The work so far has concentrated on conventional photographic imaging. Conventional photography can be regarded as the gold standard, since digital photography still often cannot obtain either the quality or resolution of conventional photography, unless using expensive equipment. Study 7, was designed to test whether a simple and relatively inexpensive digital camera, used in conjunction with computer equipment, could enable dermatological telemedicine in a store-and-forward system.

5.1.2 Methods

A portable multi-media computer was used in conjunction with a Kodak DC40 digital camera, (fitted with close up lenses - figure 2.2), and images were acquired at a resolution of 756 X 504 pixels. The colour digital images were taken by a trainee dermatologist, in a clinic with good natural lighting. Patients with either rashes or tumours participated in the study and, at the time of consultation, a brief summary of presenting symptoms and signs was noted, and was available later for a dermatologist to be used in analysis of the skin images.

Later, usually within two weeks after image acquisition, the digital images were viewed on the portable computer screen by a seperate dermatologist to the dermatologist who had first seen the patient and taken the skin images. The images were available to the viewing dermatologist, with a brief summary of presenting symptoms. The signs available to the examining trainee dermatologist were not discussed with the viewing dermatologist, but the trainee dermatologist

was available to be consulted by the analysing dermatologist in order to discuss signs viewed on the computer screen. The image-led consultant diagnoses and predicted management (from image analysis) were compared with diagnoses and management plans of the trainee dermatologist who had seen the patient in the clinic. When lesions were removed or biopsies taken, the histology was available to compare with the image-led and clinic-based diagnosis.

5.1.3 Results

Out of 100 patients attending the general practice-based dermatology clinics, there were 38 patients with rashes and 62 patients with tumour-related skin problems. There were 59 males and 41 females, age range 14yrs to 73yrs, mean 59yrs. Table 23 details the tumour referrals, and Table 24 the non-tumour referrals who attended for dermatological opinions:

Table 23
Tumour referrals for dermatological opinion.
Results of assessment by digital imaging.

Final diagnosis	Number of patients	Disagreement between assessment via digital photography (consultant) and assessment in face-to-face clinic (trainee dermatologist)
Benign melanocytic naevus	14	0
Basal cell carcinoma	10	1
Seborrhoeic wart	6	1
Actinic keratosis	5	0
Squamous cell carcinoma	5	0
Keratoacanthoma	2	1
Bowen's disease	2	0
Dermatofibroma	4	0
Haemangioma	3	0
Lentigo	2	0
Molluscum contagiosum	2	0
Sebaceous cyst	1	0
Pyogenic granuloma	1	0
Folliculitis	1	0
Chondrodermatitis nodularis helicis	1	0
Viral wart	1	0
Granuloma fissuratum	1	0
Non-specific	1	0
TOTAL	62	3

Table 24

Non-tumour referrals for dermatological opinion.

Results of assessment by digital imaging.

Final diagnosis	Number of patients	Disagreement between assessment via digital photography (consultant) and assessment in face-to-face clinic (trainee dermatologist)
Eczema	12	0
Psoriasis	6	0
Acne	2	0
Lichen planus	2	1
Pemphigoid	2	1
Granuloma annulare	1	1
Nodular prurigo	1	1
Necrobiosis lipoidica diabeticorum	1	0
Syphilis (secondary)	1	0
Alopecia	1	0
Lupus erythematosus	1	0
Tinea unguum	1	0
Haemangioma	1	0
Parapsoriasis	1	0
Callus	1	0
Epidermolysis bullosa	1	0
Drug rash	1	0
Undiagnosed	2	0
TOTAL	38	4

There was clinical agreement between the face-to-face consultation diagnosis and the diagnosis from assessment for the digital image in 59 out of 62 (95% - 95% confidence interval 87% - 99%) patients with tumours. There were no skin malignancies overlooked in the study. There was clinical agreement between the face-to-face diagnosis and the diagnosis from assessment of the digital image in 34 out of 38 (89% - 95% confidence interval 75% - 97%) patients with rashes. In the 4 patients in whom there was disagreement, there was no detrimental effect from the incorrect diagnosis in any of the patients.

The commonest skin tumour in the study was benign melanocytic naevus, followed by basal cell carcinoma and seborrhoeic wart. The commonest non-tumour problem was eczema followed by psoriasis. There was a patient with basal cell carcinoma whose skin tumour was diagnosed photographically as a squamous cell carcinoma, but the actual management plan was unaffected by the decision. During the study, in more than 50% of patients, the teledermatologist offered a wider differential diagnosis than did the trainee dermatologist who had seen the patient face-to-face in the clinic. The management plan indicated by the trainee dermatologist differed with the management plan from the teledermatologist in only 5 patients.

5.1.4 Discussion

The present study, using a mobile laptop computer with digital camera, resulted in a diagnostic accuracy of 95% for skin tumours and 89% for rashes. The higher diagnostic accuracy for tumours reflected the easier interpretation of photographs of skin tumours as compared with rashes. However, it was difficult to compare the diagnostic accuracy in this study with the previous conventional studies. Different cameras may influence diaganostic accuracy (Loane, Corbett & Bloomer, 1997; Joliffe, Whittaker & Harris, 1998; Figueroa et al, 1999), and in the present study the resolution or picture quality of the digital camera (DC40) was less than that of the Nikon conventional camera in the earlier studies. However, this should have led to a lower diagnostic accuracy in the present study, rather than the higher accuracy actually found. In the present study, the diagnosis of one dermatologist (PVH) achieved through image analysis was compared with that of the trainee dermatologist achieved in the earlier face-to-face consultation, whereas in the earlier conventional studies, the histology of the removed skin tumour was compared with the clinical diagnosis by photographic assessment. This could have influenced the diagnostic accuracy difference between the early conventional studies and this digital study.

Accepting these limitations, the diagnostic accuracy in the present study did suggest that digital images were proving effective for skin analysis. The advantage of a mobile system, using a laptop computer, could also be that the images could be used educationally for teaching purposes. In addition, the digital images could also be transmitted, thereby achieving true telemedicine. The equipment was readily available, "off the shelf" and the next study was to examine image transmission using the Internet.

5.2 Study 8. Digital Pilot Study B: An examination of Internet image transmission

5.2.1 Introduction

The Internet is a tool that is widely available for communication and knowledge exchange. The previous study, Study 7, examined a mobile system, utilising a laptop computer with digital camera. But could a digital camera be used together with a computer system for image transmission via the Internet? The present study was designed to examine Internet image transmission, and this would be a pilot study for a later ISDN-based study.

5.2.2 Methods

Using the same low-cost digital camera (DC40), shown on Figure 2.2, and mobile computer as in the previous study (study 7), colour digital images from 50 consecutive patients were recorded and transmitted via the Internet from Leeds to Lancaster, to be available for interpretation in a clinic room in the Lancaster dermatology department. Image compression was using JPEG and data encryption was undertaken to ensure information confidentiality.

There were 28 patients with skin tumours and 22 patients with non-tumour related dermatological problems. The diagnosis by assessment of the digital image on computer screen was compared with the diagnosis obtained previously by face-to-face consultation with a different dermatologist.

5.2.3 Results

There were 27 male patients and 23 female patients, age range 18yrs to 63yrs, mean 51yrs and image transferral usually took between 10 and 15 minutes for each image. Digital images from 50 patients were assessed and, with excellent image quality, the accuracy of the diagnoses from screen interpretation was found to be 94% (95% confidence interval 83% - 99%). The diagnostic accuracy for skin tumours, in this study, was not significantly different than that for non-tumour related dermatological problems.

5.2.4 Discussion

The diagnostic accuracy in this study (94%) compared favourably with the previous digital pilot study, and was higher than previous conventional studies. The higher diagnostic accuracy in the two pilot digital studies, compared with the conventional imaging, possible reflected simpler dermatological problems in patients participating in the early digital work. Furthermore, two doctors discussed diagnoses, whereas only one dermatologist assessed the conventional photographic images.

Unlike the latest study (study 9), there was image compression using JPEG (Joint Photographic Experts Group). Comparison of telediagnosis with face-to-face diagnosis would explain the higher diagnostic accuracy, in this study, than earlier conventional studies. The present study did indicate that Internet image transmission was possible as a telemedicine method, and could be used for the assessment of dermatological problems. The long transmission times were a disadvantage for the routine use of the method in this study. However, the next study (study 9), used faster ISDN image transmission.

The present study did support the use of a transmission medium, such as the Internet, for teledermatology. The next study examined a digital-based system, in which faster ISDN transmission was used for image transfer.

CHAPTER 6

DIGITAL TELEDERMATOLOGY FOR SKIN TUMOURS USING AN ISDN-BASED SYSTEM

6.1 Study 9. A digital teledermatology, ISDN-based study.

6.1.1 Introduction

Previous studies had established that conventional photography could be used to establish dermatological diagnoses and for patient management. Later, it was shown that a low-cost, low resolution, digital camera could effectively be used for the distant diagnosis of skin lesions, and the same camera could be used for image transmission through the Internet. A study was now planned, which was similar in design to that reported by Sibson (1999). The study involved two centres, at Lancaster and Manchester, and the diagnosis obtained by analysis of digital images, after image transmission, would be compared with the diagnosis obtained by face-to-face consultation as well as histological assessment of tumours. ISDN image transmission was used to increase image transfer speed and decrease transmission times.

6.1.2 Methods

Patients were invited to participate in the study, undertaken during 1998. The patients had been referred by their general practitioners to the dermatology department with skin tumours. Patients were selected randomly at either Lancaster (Queen Victoria Hospital, Morecambe) or Manchester (Hope Hospital, Salford), between January and July,1998. Exclusions included patients with larger tumours which extended outside the camera field of view, lesions obscured by hair or body contours or clothing, and lesions in genital areas. The skin lesion, or lesions (since some patients had multiple skin lesions suitable for inclusion in the study) were assessed clinically by the dermatologist who recorded the diagnosis. During the face-to-face consultation, at either Lancaster or Manchester, ratings from 1 to 5 were assigned to the diagnosis as to whether the skin lesion was definitely, probably, equivocally benign or probably/definitely malignant (1 being definitely benign and 5 being definitely malignant). Ratings from 1 to 5 were also

used to indicate whether or not the lesion could be confidently diagnosed by the face-to-face dermatologist. The degree of certainty of the first differential diagnosis was assessed using a rating from 1 to 4 and the face-to-face dermatologist also indicated the 2nd and 3rd differential diagnoses. The patient details were entered into a database (appendix 8a) and the following details were recorded:

Patient

Date of birth

Sex

Tumour site

Tumour age

Whether lesion had changed

Whether lesion had itched

Whether lesion had been bleeding

Other relevant tumour symptoms

History or evidence of excessive sun exposure

Family history of skin cancer

During each face-to-face consultation, a database entry was completed for each skin lesion (appendix 8b). Thereafter, digital images of the skin tumour (3 for each skin lesion - the best chosen for later image analysis dependent upon image quality) were taken using a digital camera (Kodak DC40) - adapted for close up work (figure 2.2). The stored image was later assessed by the remote dermatologist (separate from face-to-face dermatologist) - either at Lancaster or Manchester - and a database was completed for each patient (appendix 8c). Like in face-to-face assessment, the assessments were rated from 1 to 5 as to whether the skin lesion was definitely, probably, equivocally benign or probably/definitely malignant. Also ratings, from 1 to 5 were used to indicate whether or not the lesion could be confidently diagnosed by image analysis. Furthermore, ratings were used to assess image quality, and ratings from 1 to 4 were used to indicate the degree of certainty of the first differential diagnosis, and there was also an indication of the 2^{nd} and 3^{rd} diagnoses when possible. The appropriateness of treatment recommendation, from image assessment, was given a rating from 1 to

5. Surgical removal of skin tumours, usually undertaken, resulted in histological assessment of the skin lesion. The face-to-face diagnosis was then compared with the diagnosis achieved through image assessment, and both these diagnoses were compared with the diagnosis obtained by histological assessment of the skin lesions. This data would be used to examine the diagnostic accuracy of image assessment and ROC analysis was used to ascertain the ability of the teledermatologist to decide through image assessment whether or not a skin lesion was benign or malignant, and also the appropriateness of treatment recommended by the teledermatologist. Some patients had images taken by a medical photographer (using the same Kodak DC40 camera) instead of the dermatolgist, to establish whether or not the camera operator may influence diagnostic accuracy. Furthermore, a small number or patients had high resolution images, taken with a Kodak DC420 camera (figure 2.3), taken by the medical photographer to establish whether camera resolution could affect the diagnostic accuracy or treatment prediction by image assessment. Finally, an assessment was made during the study of any digital imaging problems.

6.1.3 Results

136 patients, 54 male and 82 female, were recruited into the study, age range 3yrs to 98 yrs, mean 55 yrs. An analysis of the histological diagnosis of the skin tumours is shown on Table 25:

Table 25
Histological diagnoses of 136 skin tumours assessed by digital teledermatology.

Histological diagnosis	No.
Benign melanocytic naevus	26
Basal cell carcinoma	13
Squamous cell carcinoma	10
Seborrhoeic wart	9
Bowen's disease	7
Normal or non-specific changes	7
Actinic keratosis	5
Squamous papilloma or wart	3
Chondrodermatitis nodularis helicis	2
Adnexal tumour	2
Eczema	2
Melanoma	1
Blue naevus	1
Angiokeratoma	1
Pyogenic granuloma	1
Benign cyst	1
Sebaceous hyperplasia	1
Nodular elastosis	1
Lichen planus	1
Histology not requested or not available	42
TOTAL	136

Image transfer time during the study was on average 8.86 seconds using ISDN 2 at 128Kb/s. The average image size was 1,135Kb. The diagnostic accuracy of the first teledermatology differential diagnosis was slightly lower than that achieved in face-to-face consultations, when compared with histological assessment of the skin tumours (53.3% versus 68.9%). However, when all 3 differential diagnosis were included the diagnostic accuracy by image assessment was 71.1% compared with 80% by face-to-face patient assessment. The diagnostic concordance

between the teledermatology assessment and face-to-face diagnosis was 60.5% (1^{st} diagnosis), but when comparing differential diagnoses, the diagnostic concordance between teledermatology assessment and face-to-face assessment was 84.4%. Using ROC analysis, the teledermatologist assessment correlated well with the face-to-face analysis (r_s=0.73, P<0.01 - Spearmans correlation coefficient). Furthermore, there was good correlation between the teledermatologist and histological findings - the latter being regarded in this study as a gold standard for diagnosis - (Z 0.88 versus Z 0.89, Kappa score 0.70.)

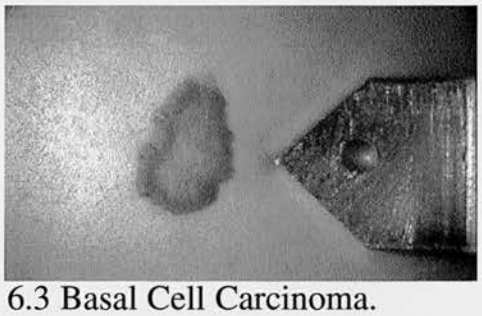
There was a tendency for the teledermatologist to be less confident in naming skin lesions than the face-to-face dermatologist (P<0.01, Students T test), and this was also found in assessing the first differential diagnosis of the skin lesion (P<0.05, Students T test). However, the teledermatologist did not indicate more differential diagnoses than the face-to-face dermatologist and it appeared that the teledermatologist was often aware of cases which would give rise to inaccuracy in diagnosis, being often less certain of the incorrect first diagnosis than the correct first diagnosis (P<0.0001, Students T test).

Digital image analysis was found to effectively distinguish between benign and malignant tumours with 93% accuracy, 87% sensitivity and 77% specificity. Furthermore, in 96% of patients, treatment recommended by teledermatology assessment was found to be adequate in the study, and in no patient was the predicted treatment via image assessment detrimental.

Certain skin lesions seemed to be particularly suitable for image assessment, with more consistency of diagnosis - particularly patients with benign melanocytic naevus, squamous cell carcinoma or basal cell carcinoma (the commonest lesion in the study). Some examples of digital images of skin lesions taken during the study are shown on Figures 6.1 to 6.8. Images of Bowens disease, basal cell carcinoma, squamous cell carcinoma and malignant melanoma are shown, taken with either a Kodak DC40 (low resolution) or Kodak DC420 (higher resolution) digital camera, the latter usually showing more detail in skin lesions:

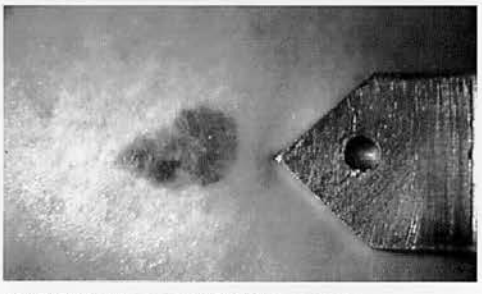
Low resolution digital images:

6.1 Bowen's Disease.
Kodak DC40



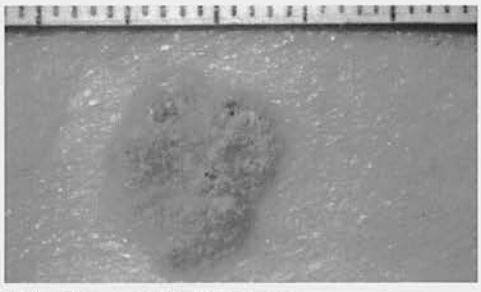
6.3 Basal Cell Carcinoma.
Kodak DC40

6.5 Squamous Cell Carcinoma.
Kodak DC40

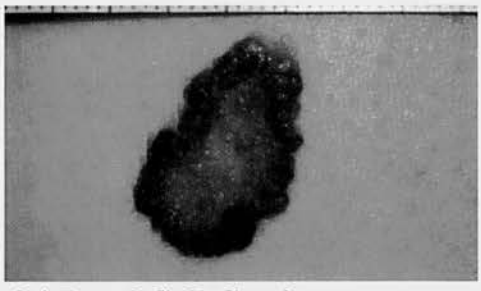


6.7 Malignant Melanoma.
Kodak DC40

High resolution digital images:



6.2 Bowen's Disease.
Kodak DC420



6.4 Basal Cell Carcinoma.
Kodak DC420

6.6 Squamous Cell Carcinoma.
Kodak DC420

6.8 Malignant Melanoma.
Kodak DC420

Figures 6.1 - 6.8 Digital images of some skin tumours in Study 9.

Inferior quality images were less likely to give accurate diagnoses, and the image quality did correlate with the diagnostic accuracy ($P<0.05$, Students T test). The teledermatologist was more certain of the first differential diagnosis with better image quality ($r_S=0.47$, $P<0.001$ - Spearmans correlation coefficient).
However, diagnostic accuracy did not appear to be significantly influenced by whether the images were taken with Kodak DC40 (less than 1 million pixels), Kodak DC420 camera (greater than 1 million pixels), or whether the images were taken by the doctor or medical photographer ($p<0.01$, Students T test).

In the present study, images were uncompressed, but image quality did depend upon a number of factors, and some imaging problems are indicated on Table 26:

Table 26
Digital imaging problems.

Reflection from pinna of ear
Difficulty in focusing on hairy areas
Difficulty in focusing on flexural areas
Poor lighting
Reflection from scalp
Difficulty in focusing near eye
Reflection from artificial light or sunlight
Shadows due to poor camera positioning
Lesion obscured by body contours
Lesion too large for field of view of camera or type of lens used
Lesion too small for assessment
Difficulty in focusing on protuberant skin lesions

6.1.4 Discussion

The diagnostic accuracy in the present study was similar to that found by Perednia, Gaines & Butruille (1995) in a study comparing 35mm photographs with digital skin images. In Perednia's study, a diagnostic accuracy of 70% was obtained in the analysis of digital images which compared with 77% accuracy by assessment of 35mm photographs. In the present ISDN-based study, the diagnostic accuracy by image assessment was found to be 61% (first teledermatology diagnosis), compared with 69% diagnostic accuracy by the face-to-face dermatologist. The diagnostic accuracy, when the differential diagnosis was taken into account, was higher (74%), but again slightly lower than that achieved in the face-to-face analysis. The present study found the diagnostic accuracy to be lower than the previous conventional studies, (studies 1 and 6) and the two earlier digital studies (studies 7 & 8). However, the ability to distinguish between benign and malignant skin tumours with digital imaging was accurate in 93% of patients, with appropriate treatment prediction in 96% of patients. Thus as in earlier conventional studies, although digital image assessment was slightly less accurate than face-to-face assessment, the method could usually effectively distinguish between benign and malignant skin tumours, with also accurate treatment predictions. These findings similar to those of Kvedar et al (1997), who concluded that still photographic imaging was suitable for dermatological examination in up to 83% of patients.

The present study, with a diagnostic accuracy of 61% for the first teledermatology diagnosis and 74% for teledermatology differential diagnosis, had better results than that reported by Grinn et al (1990) who were assessing the ability of primary care physicians to diagnose skin cancer. This may suggest that image assessment may be useful to help triage patients on dermatology waiting lists, relevant since the diagnostic accuracy of general practitioners for skin tumours may only be 50% (Harrison, 1990) In the present ISDN-based study, there was a higher concordance between the teledermatology and face-to-face assessment than that found by Lowett et al (1998). The uncompressed images may have been a factor - since image compression may give loss of lesion details, thereby reducing diagnostic accuracy (Sneiderman et al, 1994). However, Yamamoto (1995) conversely found that JPEG image compression (resulting in faster transmission time), could be used to compress images to as little as 10% of the original file size without significant quality change. It was found in the present study, however, that image quality did alter the ability of the teledermatologist to accurately

diagnose skin lesions. This is in keeping with a recent study by Piccolo et al (1999) who found that image resolution altered diagnostic ability, but not necessarily treatment prediction or patient management by image assessment. Of relevance, the Kodak DC40 digital camera used in the present study had an image resolution of only 381,024 pixels, but was usually able to give images of sufficient definition for diagnostic purposes, and today there are many readily available superior digital cameras with more than 1 million pixels.

The advantage of ISDN image transmission is its faster transmission times and therefore the system will be easier to use in routine teledermatology, although there now available a number of broad band transmission methods. The higher diagnostic accuracy in the earlier digital studies (studies 7 & 8) may reflect the easier nature of the skin lesions in those earlier studies. However, the lower diagnostic accuracy in the present study, than in some of the conventional studies, did not detract from the use of a teledermatology system using digital technology. Rather than using the method for accurate diagnosis, which might be difficult for some less typical skin tumours or rarer skin lesions, the method may be more suitable for helping triage patients on dermatology waiting lists. There were some digital imaging problems in the study and conventional cameras, in experienced hands, may give more predictable images of skin lesions. This may be of relevance for accurate diagnosis, but may not necessarily effect decisions such as whether the tumour is benign or malignant or the management of a skin lesion.

The present study did not study non-tumour related dermatological problems, which may be more difficult to assess because of greater variation in morphology, and there is often a requirement for more history to be necessary to ascertain the diagnosis of rashes compared to tumours. This study also did not examine patient satisfaction with imaging, but this had been addressed in previous conventional studies (studies 2 & 4). Furthermore, the cost analysis of digital imaging was not assessed, but this was to be the subject of analysis in a later clinical service - in which conventional photographic imaging was used for the assessment of patients (chapter 7).

So far, the 9 studies have examined conventional and digital photographic imaging, and their suitability for dermatological assessment, particularly for the management of skin tumours. It was now appropriate to introduce a pilot clinical service, and this was based initially on conventional photographic imaging.

CHAPTER 7

TELEMEDICINE FOR SKIN TUMOURS

7.1 Introduction

The final objective in the work was to establish a teledermatology service in Morecambe Bay. The studies so far (studies 1-9) had indicated similar results, for both conventional and digital imaging, in terms of diagnostic accuracy and treatment prediction for management of skin tumours. Initially, it was more practical to establish a service based on conventional photographic imaging rather than digital imaging. The reasons were primarily because of an established medical photography service in the area, plus data storage and confidentiality issues being easier to address with conventional photographic imaging. Ultimately, there would be advantages to a digital system, but the clinical service (initially based at Barrow) was first using conventional photographic imaging.

7.2 The Service

In August 1998 a weekly service was initiated in Barrow in which the medical photographer attended for photographic images to be taken of skin lesions. Patients suitable for photographic assessment were chosen from general practitioner referrals and had the following criteria:

a) lesion in accessible site
b) lesion likely to be skin tumour
c) lesion in site accessible for photography
d) lesion in non-hair bearing and non-genital site
e) lesion unlikely to be in need of urgent clinic appointment instead of photography session. An exclusion would be a patient with a suspected melanoma requiring urgent surgery
f) patient is mobile
g) patient is willing to travel for photography session
h) patient is unlikely to need significant nursing care during attendance for

photography session. An exclusion would be a patient significantly impaired by arthritis and having difficulty in dressing.

Patients were invited to attend a photographic session at Furness General Hospital, Barrow (appendix 9), and there was an option to decline a photographic assessment and instead attend a hospital clinic, for face-to-face consultation, if preferred by the patient. Patients were asked to attend the photographic session at 10 to 15 minute intervals (time interval dependant on the complexity and number of skin lesions) and a photograph taken of the skin lesion or lesions by a professional medical photographer. Clinics were held weekly, and usually 12 to 15 patients attend each session. If the medical photographer, or patient, expressed anxiety about some other skin lesion (separate from that with which the patient was referred), photographs were taken of other relevant lesions.

7.3 Service Assessment

From August 1998 to December 1998, there had been 181 patients assessed in photographic clinics. The diagnostic accuracy, comparing the photographic assessment with histological analysis after tumour removal was found to be 66% and, after assessment, 68% (range 63%-77%) of patients had operative treatment after photographic assessment.

The proportion of patients going on for operative treatment, after image assessment, did vary between the two consultants assessing photographs at Barrow - one of the consultants (VY) bringing more patients back to clinics for assessment (37.5% compared with 17%) than the other consultant (PVH) who directed more patients for operative treatment after image assessment.

A questionnaire was used to audit patient satisfaction with photographic or imaging clinics (appendix 10) and data was available on 68 patients.
The majority of patients (96%) indicated that teledermatology (using still, conventional, photographic imaging in a store-and-forward system) was acceptable, with only 28% of patients answering questionnaires indicating a preference to attend a hospital clinic rather than a teledermatology session. Although the imaging service was not true telemedicine, 90% of the patients were satisfied with the service - and the majority indicated the waiting time in the photographic clinic to be less than 5-10 minutes.

Some patients (18%) described a reduction in anxiety from the photographic attendance, which appeared to be more significant in female than in male patients. There were also differences in questionnaire answers between younger and older patients, the former expressing more concern in terms of the accuracy and confidentiality of photographic images where the latter often appeared more aware of telemedicine and believed it would speed up treatment. There were also significant differences in the response of patients from different social backgrounds, with professional and managerial people indicating that telemedicine may speed up hospital appointments, although this group also had more concerns over the technology or were more likely to be dissatisfied with the service. Unemployed or people working at home were more likely to appreciate the opportunities of telemedicine to improve medical care by reducing waiting times for hospital appointments.

A cost analysis of the photographic service indicated that it cost approximately £ 10 (excluding medical time) for each patient to attend for a photographic session - the equivalent cost for an outpatient clinic attendance being £75. This suggested that photographic sessions were approximately seven time less expensive than a patients attendance at a standard hospital clinic. Also, a photographic clinic of 20 patients could be usually assessed within 30 minutes, whereas a comparable hospital clinic would take up to 3 hours, indicating that image assessment was up to seven times quicker than if the patient attended a standard hospital clinic.

7.4 Developments

It has been planned to extend the service to include Lancaster and Kendal. Also, it is anticipated to change the conventional photography sessions to digital sessions, with image transmission to a central site. Images would be acquired in three hospital sites, with the medical photographer acquiring images in the clinics at Kendal or Barrow, and in the medical illustration department at Lancaster. From these three separate image acquisition areas, images would be transmitted to the Lancaster dermatology department for viewing and assessment by the dermatologist. The system could accept images from general practitioners and it was planned to link a health centre at Morecambe (near the site of the previous dermatology department, adjacent to Queen Victoria Hospital Morecambe) with the Lancaster dermatology department. This would form the nucleus of a Morecambe Bay (figure 7.1) teledermatology service.

Figure 7.1 Morecambe Bay. A winter landscape.
Olympus OM2 camera, 80-300 Tamron lens,
Kodachrome film ASA 200, shutter speed 1/60,
aperture f8.

CHAPTER 8

DISCUSSION

The work has largely focused on telemedicine being used in a store-and-forward system, using still photographic imaging (conventional and digital), in the management of patients with skin tumours. Modern interpretations of telemedicine require the use of a computer and telecommunication equipment (Wootton, 1998a). However, this would largely exclude conventional photography being used for telemedicine. But if a more basic definition of telemedicine is used, involving simply the practice of medicine at a distance (Sossa-Iudicissa, Wootton & Ferrer-Roca 1998), then a low-tech approach for telemedicine could involve conventional still photography.

Images have been used as means of communication since cave paintings (Calne, 1996), but paintings and drawings have continued to become both art forms and part of our everyday fabric (Gombrich, 1999). Images have many uses, from domestic to forming social functions through their art associations. But it is the photographic image, as a mirror of reality, that can captivate us by its true realism (Clarke, 1997). Medical photography is largely a 20th Century phenomenon (Cardrew, 1992), but before photography, drawings were the medium for the pictorial description of skin lesions. Early dermatology texts, including Willan's (Booth, 1999), invariably had exquisitely executed drawings or paintings of skin lesions. However, these early illustrations were usually artistic interpretations, and true realism in dermatological illustration awaited the development of photography.

Conventional photography is still regarded as the "gold standard" for photographic reproduction, although Sasson, Schiff & Stiller in 1994 suggested that digital cameras were capable of producing photographic images of acceptable quality for dermatological applications. In 1995, Perednia, Gaines & Butruille compared digital photographs with conventional 35mm photographs, and described a similar diagnostic accuracy when using both techniques for the assessment of dermatological problems. Wilcox and Grimwood (1995) used conventional photography in assessing dermatological problems and, in the same

year, Perednia and Brown (1995) used digital photography during an assessment of telemedicine. An Australian study (Del Mar & Green, 1995) used Polaroid images which helped in the diagnosis of melanoma, and other skin lesions, in primary care. Gilmour et al (1998), together with other workers, have examined video-conferencing for teledermatology, but there have been few studies in the United Kingdom examining store-and-forward telemedicine for dermatological applications (Wootton, 1998b), although this has been addressed in other parts of the world (Provost, 1998; Tait & Clay, 1999). Although the eventual aim, in Morecambe Bay, was to establish a telemedicine service, the present work was undertaken to examine whether still photography, in a store-and-forward telemedicine mode, could reasonably be used for assessing patients with dermatological problems.

In any assessment of telemedicine, it is important to establish whether it could replace the examination of patients in a face-to-face clinic. However, the assessment of patients in clinics may be subject to inter-observer variation, and the histological assessment (less subject to variation) will be a better standard with which to compare telemedicine assessment. When histological assessment using telemedicine was compared with the clinical assessment using telemedicine, in the present studies the pathologist was unaware of the study of patients and was not influenced by the clinical diagnosis of the dermatologist.

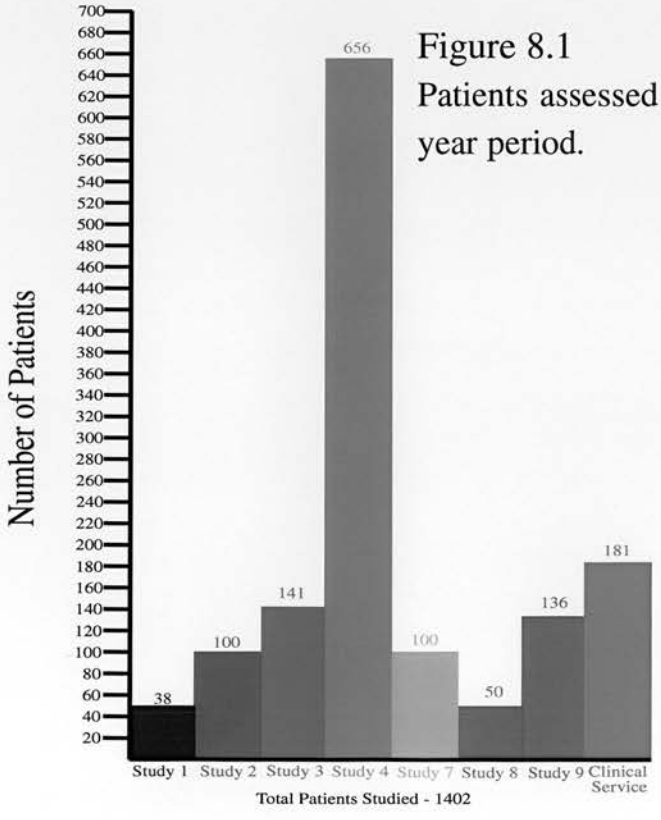


Figure 8.1
Patients assessed using teledermatology over a five year period.

Within Study 4, 291 of the patients answered questionnaires in Study 5, and 75 general practitioners were sent questionnaires in Study 6

Studies 1 to 6 involved conventional photographic imaging, where Studies 7 to 9 involved the use of digital cameras and computer equipment – with subsequent image transmission – and only these involved true telemedicine, (Sossa-Iudicissa, Wootton & Ferrer-Roca 1998). Over a 5 year period, 1402 patients were studied, and 366 questionnaires were issued to patients or general practitioners. Figure 8.1 summarises the patients assessed using teledermatology, during this period:

Study 1 examined whether conventional photographic images could be used for dermatological diagnosis in an assessment of 38 conventional photographs of skin lesions from 26 patients. In this study, a diagnostic accuracy of 82% was achieved when the image assessment diagnosis was compared with that obtained after histological removal of the skin tumour. Study 2 involved 100 patients not involved in any of the other studies, and examined the acceptance of photographs being used for dermatological assessment. Patients were asked to complete a visual analogue scale, and after an explanatory interview 94% indicated satisfaction with photographic imaging for lesion assessment, rather than hospital clinic attendance. These findings were consistent with studies by Loane, Bloomer and Corbett (1998) and Lowett et al (1998), although they were examining real-time teledermatology rather than a store-and-forward system. In Study 3, the medical photographer took photographic images of the patients in the Lancaster medical illustration department, rather than dermatology clinics. But, despite the superior photographic environment of the photographic studio being used, the diagnostic accuracy (comparing image assessment with histological assessment of the skin tumour) was actually lower (62%) than in the earlier pilot study (study 1). However, in Study 3, there were no skin lesions which would have been mismanaged by photographic assessment, and, furthermore, the diagnostic accuracy by image assessment was higher than the diagnostic accuracy of the referring general practitioners (51%), when compared with the histological assessment. There were 141 patients in Study 3, but the next study (study 4) examined conventional photographic assessment in 656 patients – in three hospital sites (Lancaster, Kendal and Barrow).

In Study 4, the data was separated into three groups, after histological analysis of treated tumours, and the mean diagnostic accuracy (comparing photographic assessment with histological assessment of surgically removed skin tumours) was 73% in 574 patients completing treatment. In this study, there was no significant difference between the diagnostic accuracy of image assessment of urgent skin lesions compared with less urgent or benign skin tumours. The assessment of skin

tumours by conventional photography enabled the distinction between benign and malignant skin tumours, with a mean 94% accuracy. Furthermore, there was a mean 94% accuracy in treatment prediction using conventional photographic imaging comparing treatment prediction by image analysis with the actual treatment subsequently undertaken on the skin tumour. This was relevant for patient management, and could be useful in triaging patients on dermatology waiting lists. In this situation, appropriate management may be more relevant than accurate diagnosis. During Study 4, there was a reduction in dermatology waiting lists of 75% over the 6 month study period, across the three hospital sites, but there appeared to be no significant differences in the assessment of skin tumours between the different hospitals.

Study 5 examined patient satisfaction with photographic imaging at Lancaster, Kendal and Barrow. Questionnaires were completed by 291 patients (out of the 656 patients attending for photographic imaging), but the response appeared to be uniform across the three hospital sites, and 85% of the patients completing pretreatment questionnaires indicated a preference to being seen in a hospital clinic rather than attending a photographic session. Of those patients completing post-treatment questionnaires (49 patients), all appeared satisfied with their treatment following their attendance at the photographic session, with only 3% of patients unsatisfied with the imaging service. In Study 6, 49 general practitioners completed questionnaires and most (89%) were satisfied with the time from patient referral to image assessment, time from image assessment to skin treatment (82%). General practitioners also indicated satisfaction with the diagnostic information (88%) and the management plan (84%). However, in this study, a significant number of general practitioners (33%) did indicate minor problems with the photographic assessment, but most of these were encountered during the early stages of the study, and not related to the diagnostic accuracy or patient management.

The studies so far had involved conventional photographic imaging (studies 1 to 6). However, digital photography now compares favourably, in image resolution, with conventional photography (Perednia,1991). The next three studies (studies 7 to 9) examined digital technology for telemedicine.

Although there are now many digital cameras with image resolution of greater than one million pixels, and likely to give superior photographic quality, Study 7 involved a mobile computer system with a digital camera having a resolution of

381, 024 pixels. In this study, the diagnostic accuracy using image assessment was greater for skin tumours (95%) than in patients with rashes (89%). However, unlike the previous conventional studies (studies 1 to 6), the diagnostic accuracy was obtained by comparison of the image assessment diagnosis with the face-to-face diagnosis, both by separate dermatologists. This may explain the higher diagnostic accuracy in Study 7 than earlier conventional imaging studies. Study 7 also indicated the good correlation between the patients management based upon digital image assessment, when compared with treatment suggested from face-to-face consultations. Study 8 used the same camera as in Study 7, but instead of images being brought to the dermatologist for assessment using a mobile computer, Internet transmission was used in the telemedicine study. As in Study 7, the higher diagnostic accuracy (94%) almost certainly reflected the use of face-to-face diagnoses with which to compare the diagnosis from image assessment by the teledermatologist, rather than the comparison with the histology from the same patients. In both Studies 7 and 8, the dermatologist achieved a higher diagnostic accuracy when dealing with tumours compared with the assessment of rashes. Jolliffe, Harris and Whittaker (2001) also used the histological diagnosis as the "gold standard", rather than clinical diagnosis, in a teledermatology study. A similar diagnostic concordance was found between face-to-face diagnosis and image assessment, although a lower diagnostic accuracy (47% for image assessment and 43% for face-to-face examination) than in the present studies. Also, there were fewer skin malignancies in their study, whereas skin malignancy was well represented in the present studies.

Although image transmission can be achieved, using conventional or Polaroid photographs, with computer scanning, for the practical use of telemedicine rapid image transmission is important, and the next study (study 9) examined ISDN image transmission between two dermatology centres, Lancaster and Manchester. In this study, the diagnostic accuracy by image assessment was found to be 61% (first teledermatology diagnosis), compared with 69% accuracy by the face-to-face dermatologist. When the differential diagnosis of skin tumours was taken into account, the diagnostic accuracy was higher (71% compared with 80% in the face-to-face analysis, with a diagnostic concordance between teledermatology assessment and face-to-face assessment of 84%. These results were comparable with those obtained in earlier conventional imaging studies, but lower than that achieved more recently by Piccolo et al (1999). In the latter study, a diagnostic concordance of 86% was found when the telediagnosis was compared with the histological diagnosis, and was even higher (91%) comparing face-to-face

diagnoses with the telediagnosis. In the study by Piccolo et al (1999), the accuracy of telediagnosis did not appear to relate to image quality, but did depend upon the level of diagnostic difficulty with individual tumours. In Study 9, there was an excellent ability to distinguish between benign and malignant skin tumours (93% accuracy), with good treatment prediction (96% accuracy). These findings were consistent with results obtained in earlier conventional imaging studies. Furthermore, this ability to accurately predict treatment of skin tumours, assessed in both Study 4 and 9, was consistent with findings by Oakley et al (1998), who concluded that teledermatology was useful for the clinical management of dermatological patients. However, the good treatment prediction ability of teledermatology in the present studies, found in both studies 4 and 9, being superior to diagnostic ability was at variance to those findings by Whited et al (1999), who found that teledermatology using digital imaging appeared less useful for dermatological management than diagnosis. However, in the study by Whited et al (1999), a range of dermatological conditions were studied, including tumours and rashes, whereas in the present Studies 1 to 9 and clinical service most patients studies had skin tumours. There are usually fewer diagnostic decisions for tumours, when compared with rashes, making telemedicine often more suitable – particularly in store-and-forward mode.

On completion of Studies 1 to 9, a pilot clinical telemedicine service was established, initially based at Barrow-in-Furness. Conventional photography was used in a store-and-forward system, but in the data analysis there was a lower diagnostic accuracy (66%) than in many of the earlier studies. This could have reflected the tendency of the teledermatologist to over diagnose certain skin problems (particularly malignant tumours). An assessment of the patients attending the pilot clinical service suggested that certain patients would more readily accept telemedicine, more elderly or female patients appearing to have fewer reservations concerning telemedicine. Telemedicine may not be suitable for all patients, and, indeed, telemedicine may not suit all medical practitioners. The most recent assessment of the pilot clinical service, in Morecambe Bay, has suggested that variations in normal dermatological practice between consultants may influence telemedicine outcomes (Wong et al, 2000). Also, there may be cultural differences in patients' attitudes towards telemedicine or teledermatology which may need addressing in service planning.

A summary of diagnostic accuracy, benign/malignant assessment, and the treatment prediction of patients in the various studies (including pilot clinical service) are shown on Figures 8.2 to 8.4.

Figure 8.2-8.4. Summary of diagnostic accuracy, benign/malignant assessment and treatment prediction of patients in the studies.

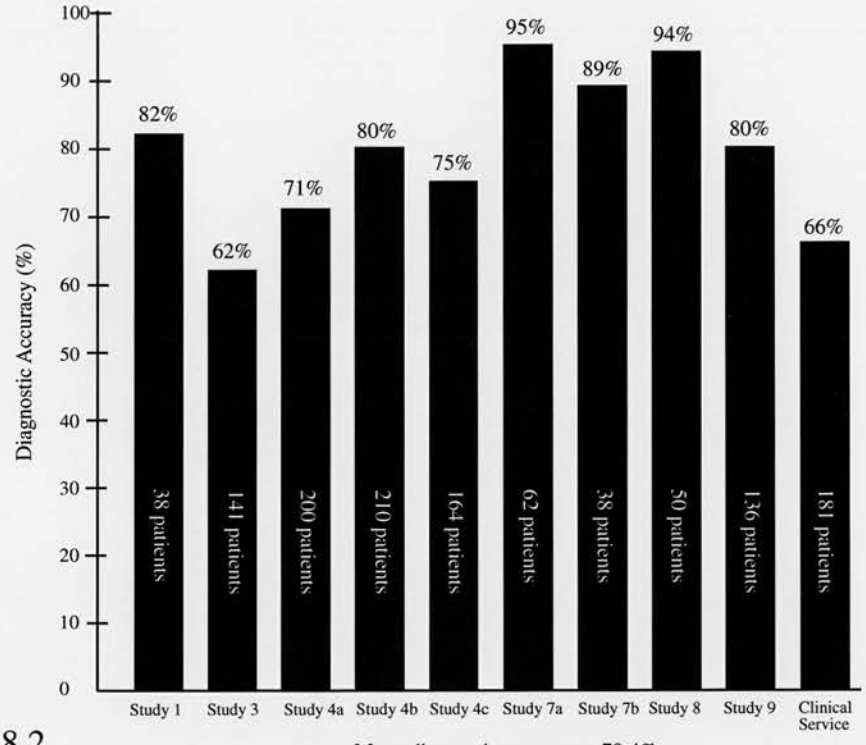
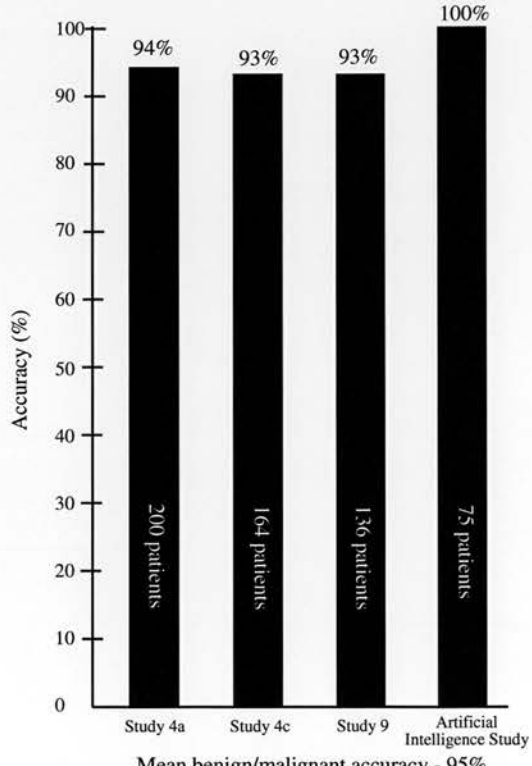


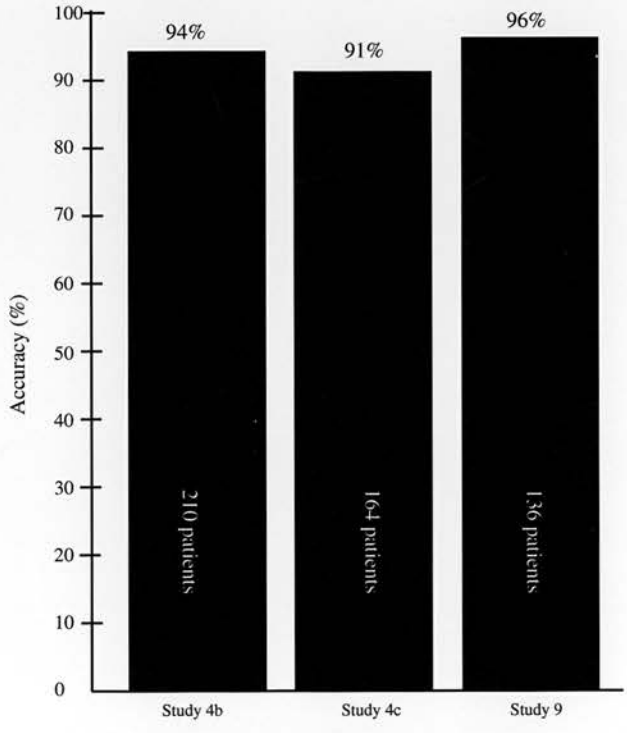
Figure 8.2

Mean diagnostic accuracy - 79.4%
Studies 7, 8 & 9 were digital, the other patients were assessed using conventional photographic imaging



Mean benign/malignant accuracy - 95%
Study 9 was a digital study, 4a and 4c were based on conventional photographic imaging. The artificial intelligence work was a seperate study (Andrews et al, 1999)

Figure 8.3



Mean treatment prediction accuracy - 93.6%
Study 4b and 4c used conventional photography, whereas Study 9 involved digital photographic imaging.

Figure 8.4

There are differing opinions as to the value of telemedicine (Harrison, 2000). On the one hand, Charles-Holmes & Thomson (1997) indicated that there was no evidence of telemedicine facilitating quicker, or more effective, dermatological consultations. They were against the practice of teledermatology (Charles-Holmes, Humphreys & Thomson, 1997) although others have supported telemedicine, including Gilmour (1997), and there is now growing evidence of the usefulness of telemedicine (Grigsby & Saunders, 1998; Wootton, 1998a). It has been suggested that a significant proportion (up to one third) of dermatology patients could be managed using telemedicine (Taylor et al, 2001).

A recent article in the British Medical Journal (Wootton et al, 2000) indicated clinical benefits, but not cost effectiveness, from real-time teledermatology using video-conferencing. Wootton's group also, separately, compared store-and-forward teledermatology with assessment using video-conferencing and concluded that a still photographic system was more likely to be cost effective (Loane, 2000). A criticism of teledermatology can be lack of flexibility and inability to examine the whole patient (Jolliffe, Harris and Whittaker, 2000), but in the Morecambe Bay studies the medical photographer was briefed to take extra photographs or to take into consideration patients concerns about any other skin problem.

In the various Studies (1 to 9), and pilot clinical service, both conventional and digital photography was used for assessing skin problems, particularly skin tumours. Telemedicine was achieved in a store-and-forward system, although digital technology more readily achieved true telemedicine. A recent editorial in the British Medical Journal (Florrin & Rosen, 1999) expressed concern over the introduction of some new services into the NHS. However, medicine is changing, and there has been the introduction of NHS Direct and, more recently NHS online, which have initiated new ways of delivering medicine using new technology. Telemedicine is still in its infancy, but as more people become involved it will become part of everyday practice in medicine. However, it is important to adequately plan telemedicine services, emphasised by White (1999) who concluded that the availability of specialist time was a limiting factor in the expansion of telemedicine. Also, it is important to utilise experienced personnel in the assessment of patients through telemedicine. Piccolo et al (1999) found, not unsurprisingly, better outcome results with more experienced telemedicine operators, but this is also to be expected in any branch of medicine – where more skilled medical personnel will inevitably give a superior service.

Whether telemedicine utilises a real-time system, using video-conferencing or a store-and-forward system, involving photographic imaging, may depend upon local needs and what particular dermatological problems need assessment. Certainly the store-and-forward system appears to be more suitable for skin tumour assessments, which may have implications for skin cancer screening. It is debatable whether cameras should be situated in general practice (operated either by doctors, nurses or other personnel) or hospital-based image acquisition. The advantages of imaging in general practice, and then sending the data to the dermatologist at the hospital, are convenience for the patients and flexibility for the general practice. However, to ensure image quality and consistency of image, there may be an advantage in central image acquisition at a hospital or health centre - where there may be more opportunity to use trained photographic personnel to undertake the imaging of skin lesions. Also, a higher diagnostic accuracy may be achieved with better image quality obtained by professional personnel taking photographs (Loane, 2000). Tumours may be more suitable than rashes for assessment by store-and-forward telemedicine methods. However, video-conferencing may be more suitable for the evaluation of rashes, where history taking may be more relevant for diagnosis.

We no need more work before telemedicine becomes universally accepted, and more studies are necessary, particularly in certain areas of telemedicine. Medico-legal issues continue to be relevant, both in telemedicine and conventional medicine, and more work is necessary in this area. Both patients and doctors are maybe more vulnerable using telemedicine rather than practising in conventional hospital clinics, but it is important that patients receive the same standard of care that would normally be available in non-telemedicine situations. Also, more work is necessary examining patient outcomes, but there is surprisingly little information concerning the accuracy of conventional medical practice (Wootton & Loane 1998). Futhermore, some workers still have reservations concerning the technical reliability of telemedicine (Taylor et al, 2000).

Finally, in planning telemedicine services, it is important to take into consideration local needs, so that telemedicine is suitable for both doctors and patients. Different telemedicine methods may suit different specialities or doctors, and not all patients are suitable for telemedicine. In the final analysis, although telemedicine (and teledermatology) can be used to benefit patient care, it is best used in association with conventional medicine. Telemedicine is a useful adjunct

to existing services, and should not be thought of as an alternative to the conventional and traditional practice of medicine. Furthermore, in a geographical area such as Morecambe Bay, photographic imaging may be more usefully employed for the management of patients with skin tumours by having image acquisition in a primary care setting, rather than using more central image acquisition which may be more suitable in urban areas.

CHAPTER 9

CONCLUSIONS

Figure 9.1 Sunset over Morecambe Bay.
Olympus OM2 camera, 80-300 Tamron lens, Fujifilm
ASA 200, shutter speed 1/30, aperture f5.6.

The work has examined whether still photographic imaging can be used for achieving telemedicine in dermatology. It was found that still photographic imaging, in a store-and-forward system, could effectively diagnose skin lesions, whether utilising conventional or digital equipment. The advantages of conventional photography were mainly in terms of availability of equipment and expertise, reproducibility of results, and quality of images. Dermatological diagnosis from conventional photographs helped in waiting list management or patient triaging, and could be established in any area with access to a medical illustration department. The advantages of a digital system were in terms of data transmission and possible faster image analysis. It was found that both conventional and digital methods could effectively distinguish between benign and malignant skin lesions, and be used to accurately predict tumour treatment.

It is important to build into any development adequate resources for treatment, particularly skin surgery. Telemedicine is a useful adjunct to conventional medicine, and should not be thought of as a replacement for doctors, nor to replace vital existing resources. Furthermore, telemedicine is unlikely to reduce the number of dermatologists required to deliver patient care. Telemedicine has an important role in the future NHS, and indeed in many parts of the world, where there is an increased requirement for access to medical care. Photographic image assessment can enable patient management, whether using conventional or digital methods, but true telemedicine can be more readily achieved using digital technology.

Work began with a review of illustrations and images in dermatology, and the history of photography and medical photography provided an introduction to telemedicine. Teledermatology, in a store-and-forward system, was achieved using still photographic imaging of skin tumours, either conventional or digital, and was then put into practice in Morecambe Bay.

Telemedicine is not 100% accurate, but neither is traditional medicine where there is often a lack of agreement between doctors (Ramsey & Benimorff, 1981). Clinical diagnosis is difficult (Grin et al, 1990) - whether in the clinic or by telemedicine. More work needs to be undertaken before telemedicine is firmly established within routine medical practice.

The work has not examined in detail different cameras, or different computer systems, but did assess readily available 'off the shelf' equipment. Also, doctor and patient views were not compared with management views of telemedicine, and outcome measures need more detailed comparative analysis. Telemedicine still requires careful assessment (Mair & Whitten, 2000), and it should not be introduced as a reduced-cost, 'quick fix' for an underfunded NHS - if it is to effectively help with the increasing demands on medicine. Telemedicine needs to be developed in a national strategy (Wootton, 1998), of relevance to dermatology with current underfunding of the speciality.

CHAPTER 10

THE FUTURE

Working in conjunction with Lancaster University, studies based on neural networking computers (with fractal and chaos theory analysis) has enabled computer-led assessment of photographic images of skin tumours (Andrews et al, 1999). The computer system was compared with a panel of 12 general practitioners and 8 nurses, assessing their ability to determine whether a skin lesion was benign or malignant. The computer system achieved an accuracy of 100%, compared with a 78% accuracy by the general practitioners and 81% accuracy by nurses - which compared to the best human accuracy of 94% for benign/malignant assessment (study 4). An image of a halo naevus, with computerised colour analysis used in this study, is shown on figure 10.1:

A

B

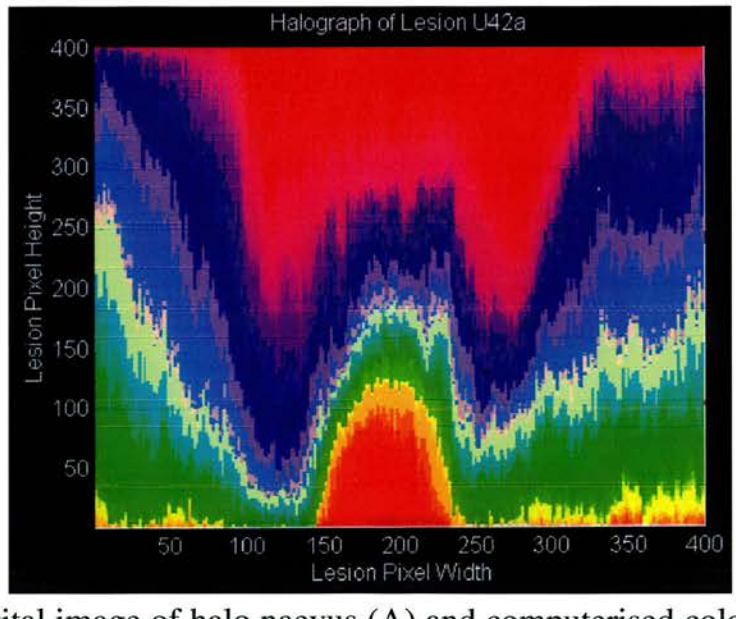


Figure 10.1 Digital image of halo naevus (A) and computerised colour analysis (B)

Machine intelligence, achieving automatic or semi-automatic skin assessment could be available in a general practice, at the hospital, or even be available "on line" via a web site, the latter used by doctors or possibly patients. In Morecambe Bay, a pilot website has been established for dermatological use. There now exists NHS Direct and NHS On-line, but with the next generation of digital telephones, there is the possibility of either patients or doctors accessing medical information more readily through the Internet and other media and there is now even the possible reality of virtual hospitals. Furthermore, the latest digital telephones allow direct image transmission through the Internet, thereby more easily facilitating portable telemedicine (figure 10.2):

Figure 10.2. Digital photograph of pigmented seborrhoeic wart on face (camera resolution 1.3 million pixels), transmitted from general practice to hospital, via mobile phone and Internet.

Other applications of telemedicine in dermatology include enhanced education through video-conferencing, and we have established a link with a local general practice, based at Windermere, to enable practice-based general practitioner education. Also, it is hoped to reduce travelling times during future dermatology nursing courses, by using video-conferencing links between Lancaster, Kendal, Barrow and other centres. Another initiative has established mobile acne assessment using digital imaging, in a store-and-forward telemedicine system.
In the North West of England, the dermatology department at Manchester has established a clinical service using telemedicine, largely based on findings of Study 9 - which involved joint work between Lancaster and Manchester. Also, in Preston, the plastic surgery department has initated a pilot study examining the traging of patients on waiting lists, with direct booking of patients for operative treatment.

We live in a rapidly progressing world, in which medicine is developing at an often phenomenal rate. However, we must not lose sight of the fact that people

still often turn to traditional values and telemedicine cannot replace the human aspect of medicine (figure 10.1). Telemedicine may work, but should not be seen as an automatic alternative to conventional approaches in medicine. Medicine is as much an art as a science and telemedicine, as a science, cannot replace the artistry of medicine. Telemedicine may have a significant impact on medicine, but should be kept in perspective- and is an additional means of helping patients.
Telemedicine has the support of the Government, the patients, and many who work within the NHS (Wallace, 1999). However this commitment needs to be matched by resources to effectively enable a comprehensive service. Properly implemented, and supported, telemedicine, including teledermatology, is a new science with enormous opportunities within the practice of medicine.

Figure 10.3 Middle Meadow Walk, Edinburgh.
Olympus OM2 camera, 80-300mm, Tamron lens,
Fujifilm ASA 400, shutter speed 1/125, aperture f16.

REFERENCES

Alibert, J.L.M. (1806) Description des maladies de la peau, observees a l'Hopital Saint Lous, et exposition des meilleures methodes suivies pour leur traitement. *Auguste Wahlen, Paris.*

Alibert, J.L.M. (1832) Monographie des dermatoses; ou precis theorique et pratique des maladies de la peau. *Janet Roux, Paris.*

Allen, A. (1999) Telemedicine - A global perspective. In: European Telemedicine. Edited by Wootton, R. *Kensington Publications, London.*

Andreae, M. (1996) Confidentiality in medical telecommunication. *Lancet.* 347, 487-488.

Andrews, S.G., Zein, N.F., Honary, B., Harrison, P.V. (1999). Self-organising adaptive neural architectures derived from dermatological images used in tumour diagnoses. *In Preparation.*

Araujo, S. (1883) Atlas des maladies de la peau. *Rio De Janeiro.*

Bateman, T. (1817) Delineations of cutaneous diseases: exhibiting the characteristic appearances of the principle genera and species comprised in the classification of the late Dr Willan; and completing the series of engravings begun by that author. *Longman, London.*

Baxandall, J. (1995) Shadows and Enlightenment. *Yale University Press, New Haven.*

Bittorf, A., Krejci-Papa, N.C., Diepgen, T.L. (1995) Development of a dermatological image atlas with world wide access for the continuing education of physicians. *Journal of Telemedicine and Telecare.* 1,45-53.

Blewitt, R.W (1995) Personal Communication.

Blignault, I., Kennedy C. (1999) Training for telemedicine. *Journal of Telemedicine and Telecare.* 5, supp 1, 11-14.

Booth, C. C. (1999) Robert Willan MD FRS (1757-1812) Dermatologist of the Millennium. *Journal of the Royal Society of Medicine.* 92, 313-318.

Brahams, D. (1997) The medicolegal implications of teleconsulting in the U.K. *Journal of Telemedicine and Telecare. 1,196-201.*

Brown, S. (1994) Digital Imaging and Clinical Photography, Part 1. *Journal of Audio Visual Media in Medicine.* 17, 53-65.

Burns, S.B. (1979a) Early medical photography in America (1839-1883) III. The Daguerrean era. *New York State Journal of Medicine.* 79, 1256-1268.

Burns, S.B. (1979b) Early medical photography in America (1839-1883) IV. Early wet-plate era. *New York State Journal of Medicine.* 79, 1931-1938.

Burns, S.B. (1979c) Early medical photography in America (1839-1883) VI. Civil War medical photography. *New York State Journal of Medicine.* 80, 1444-1469.

Cadava, E. (1997) Words of light. Thesis on the photography of history. *Princeton University Press, Princeton.*

Calne, R. (1996) Art, surgery and transplantation. *Williams & Wilkins, London.*

Cardew, P. (1992) Early days in the St Mary's Medical School Photographic Department. *Journal of Audio Visual Media in Medicine.* 15, 133-137.

Cazenave, A. (1845) Leçons sur le maladies de la peau. *Paris.*

Charles-Holmes, R., Thomson, K. (1997) Enthusiasm for telemedicine in dermatology may be misplaced. In: Dermatopics, edited by Pinn, S. *Pegasus Healthcare International, Reading.*

Charles-Holmes, R., Humphreys, F., Thomson, K. (1997) Telemedicine in dermatology- inappropriate enthusiasm. *British Journal of Dermatology, 137 (suppl 50), 17.*

Clarke, C.D. (1990) The development of photographic chemistry. *Journal of Biological Photography.* 60, 148-152.

Clarke, G. (1997) The photograph. Oxford history of art. *Oxford University Press, Oxford.*

Clusisus, C. (1576) Rarorium aliquot stirpium per Hispanias observatarum historia. *Antverp.*

Colonna, F. (1592) Sive, plantarum aliquot historia....; accessit etiam piscium aliquot plantarumque novarum historia..../ *Fabio Colonna.- Neapoli: H, Salviani.*

Curry, R.G., Norris, A.C., Parry, S. (1997) The strategic development and application of telemedicine. *Informatics in healthcare. 6,107-112.*

De Barker, D.A.R. (1996) Can photographic referrals ensure priority is given to dysplastic lesions? *British Journal of Dermatology.* 125, supp 47, 32.

Del Mar, C.B., Green, A.C. (1995) Aid to diagnosis of melanoma in primary medical care. *British Medical Journal.* 310, 492-495.

Dockrell, M. (1905) An atlas of dermatology, showing the appearances, clinical and microscopical, normal and abnormal, of conditions of the skin. *Longmans, Green & co., London, New York & Bombay.*

Dodd, B. (1999) Telemedicine: Curse or blessing? *British Journal of Health Care Computing and Information Management.* 16,22-24.

Duchenne, G.B.A. (1862) Album de photographies pathologiques complementarie du liver intitulee de l'electrisation localise *J.B. Bailliere st fils, Paris.*

Duhring, L.A. (1876) Atlas of skin diseases. *Lippencott & co. Philadelphia.*

Dusel, F., Walton, R., Cole, W., Chung-Hong H. A medium-format photographic protocol to aid in the management of dysplastic nevi syndrome (1990). *Journal of Biological Photography.* Vol 58, No. 4, 107-111.

Eedy, D,J., Wooton, R. (2001) Teledermatology: a rewiew. *British Journal of Dermatology.* 144, 696, 707

Exhibition. (1997) Drawings from the Royal Collection: Cassiano dal Posso's paper museum. *National Gallery of Scotland, Edinburgh.*

Ferrer-Roca, O. (1998) The main telemedicine applications. In: Handbook of Telemedicine, edited by Ferrer-Roca, O & Sosa-Iudicissa, M, *IOS Press, Amsterdam.*

Figueroa, J.I., Fuller, L.C., Higgins, E.M., Rojas, M., Hay, R.J. (1999) An assessment of the accuracy of digital images for teledermatology referals: a pilot study comparing the images from two digital cameras. *British Journal of Dermatology.* 141 suppl 55, 44.

Florin, D., Rosen, R. (1999) Evaluating NHS Direct. *British Medical Journal.* 319,5-6.

Form and Reading (1997) An introduction to the humanities. *Open University. Milton Keynes.*

Foster, J., Jessopp, L., Dale, J. (1999) Concerns and confidence of general practitioners in providing telephone consultations. *British Journal of General Practice.* 49, 111-113.

Fox, G.H. (1880,1900) Photographic atlas of diseases of the skin. *Lippencott, Philadelphia & London.*

Fox, W.T. (1877) Atlas of skin diseases consisting of a series of coloured illustrations together with descriptive text and notes upon treatment. *Churchill, London.*

Galassi, P. (1998) American photography (1890-1965) *The Museum of Modern Art, New York.*

Gilmour, E. (1997) Telemedicine in dermatology- how it might work. In: Dermatopics, edited by Pinn, S. *Pegasus Healthcare International, Reading.*

Gilmour, E., Campbell, S.M., Loane, M.A., Esmail, A., Griffiths, C.E., Roland, M.O., Parry, E.J., Corbett, R.O., Eedy, D., Gore, H.E., Mathews, C., Steele, K., Wootton, R. (1998) Comparison of teleconsultations and face-to-face consultations: preliminary results of a United Kingdom multicentre teledermatology study. *British Journal of Dermatology.* 139,81-87.

Gombrich, E.H. (1999) The uses of images. Studies in the social function of art and visual communication. Phaidon Press, London.

Gracianski, P., Boulle, S. (1952) Altas de dermatologie, *Paris*

Grigsby G., Sanders, J.H. (1998) Telemedicine: Where it is and where it is going. *Journal of Internal Medicine.* 15,123-127.

Grin, C.M., Kopf, A.W., Velkovich, B., Bart, R.S., Leventsein, M.J. (1990) Accuracy and the clinical diagnosis of malignant melanoma. *Archives of Dermatology.* 126, 763-766.

Hanley, J.A., McNeil, B.J (1982) The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology.* 143, 29-36.

Harrison, P.V. (1990) Personal observations.

Harrison, P.V. (2000) Telemedicine: the argument for and against. *Dermatology in Practice.* 8, 16-18.

Hebra, F. (1872, 1876) Atlas des Hautkrankheiten. *Wein.*

Hutchinson, J. (1878). Illustrations of clinical surgery. *J & A Churchill, London.*

Information for Health. (1998) An information strategy for the modern NHS, *Department of Health Publishers, Wetherby.*

Jacobi, E. (1910) Portfolio of dermochromes. *Rebman, London*

Jolliffe, V.M.L., Whittaker, S.J., Harris, D. (1998) Teledermatology: reliability of video images in triage of pigmented lesions compared to conventional direct visual imaging. *British Journal of Dermatology.* 139, suppl 51, 52.

Jolliffe, V.M.L., Harris, D.W., Whittaker, S.J. (2001) Can we safely diagnose pigmented lesions from stored video images? A diagnostic comparison between clinical examination and stored video images of pigmented lesions removed for histology. *Clinical and Experimental Dermatology.* 26, 84-87

Kaposi, M. (1899) Hand atlas for students and doctors. *W Braumuller, Vienna.*

Kvedar, J.C., Edwards, R.A., Menn, E.R., Mofid, M., Gonzaliz, E., Dover, J., Parrish, J.A. (1997) The Substitution of digital images for dermatologic physical examination. *Archives of Dermatology.* 133, 161-167.

Lanske, C. (1996) Legal Issues in Medical Infomatics : A birds eye view towards security. In: Medical Informatics: Legal and ethical aspects. *Barber, Treacher & Louwerse. ISO Press, Oxford.*

Lawson, J. (1992) The stones of Venice. *Scottish National Portrait Gallery, Edinburgh.*

Le Loir, H., Vidal, E. (1889) Traite descriptis des maladies de la peau. *Masson, Paris.*

Lesher, J.L., Davis, L.S., Gourdin, F.W. (1998) Telemedicine evaluation of cutaneous diseases: a double blinded study. *Journal of the American Academy of Dermatology.* 38,27-31.

Light from the darkroom. (1995) A celebration of Scottish photography. *National Gallery of Scotland, Edinburgh.*

Loane, M. (1998) Real-time teledermatology. In: European Telemedicine, edited by Wootton, R. *Kensington Publications, London.*

Loane, M. (1999) Patient cost-benefit analysis of teledermatology measured in a randomised control trial. *Journal of Telemedicine and Telecare.* 5, supp1, 1-3.

Loane, M. (2000) Personal communication.

Loane, M.A., Corbett, R., Bloomer, S.E. (1997) Effect of camera performance on diagnostic accuracy: Preliminary results from the Northern Ireland arms of the U.K. multi centre teledermatology trial. *Journal of Telemedicine and Telecare.* 3, 83-88.

Loane, M.A., Bloomer, S.E., Corbett, R. (1998) Patient satisfaction with real-time teledermatology in Northern Ireland. *Journal of Telemedicine and Telecare.* 4,36-40.

Loane, M.A, Corbett, R. Bloomer, S.E., Eedy, D.J., Gore, H.E., Mathews, C. Steele, K., Wootton, R. (1998) Diagnostic accuracy in clinical management by real-time teledermatology. Results from the Northern Ireland arms of the U.K. multicentre teledermatology trial. *Journal of Telemedicine and Telecare.* 4,95-100.

Loane, M.A., Bloomer, S.E., Corbett, R., Eedy, D.J., Hicks, N., Lotery, H.E., Mathews, C., Paisley, J., Steele, K., Wootton, R. (2000) A comparison of real-time and store-and-forward teledermatology: A cost-benefit study. *British Journal of Dermatology.* 143, 1241-1247

Locke, J. (1994) An essay concerning human understanding. *John Churchill, London.*

Lowitt, M.H., Kessler, I.I., Kauffman, L., Hooper, F.J., Siegel, E., Burnett, J.W. (1998) Teledermatology and in-person examination–a comparison of patient and physician perceptions and diagnostic agreement. *Archives of Dermatology.* 134, 471-476.

Maclean, J.R., Brebner, J.A., Norman, J.N. (1995) A review of Scottish telemedicine. *Journal of Telemedicine and Telecare.* 1,1-6.

Mark, P.D. (1991) Radio aid to ships at sea. *Medical Journal of Australia.* 55, 761-771.

Mair, F., Whitten, P. (2000) Systematic review of studies of patient satisfaction with telemedicine. *British Medical Journal.* 320, 1517-1520.

Metz, C.E. (1989) Some practical issues of experimental design and data analysis in radiographic ROC studies. *Investigative Radiology.* 24,235-245.

Michaelis, J., D'Souza (1999) Teledermatology via the Internet. *Journal of Telemedicine and Telecare.* 5, suppl, 135-136.

Morrow, P.A. (1894) System of genitourinary diseases. Vol 3 pts 1&2, Dermatology. *Pentland, Edinburgh & London.*

Morrow, P.A. (1899) Atlas of skin and venereal diseases. *William Wood & co., New York.*

Neumann, I. (1890) Atlas de hautkrankheiten. *Braumuller, Vienna.*

Norton, S.A., Burdick, A.E, Phillips, C.M., Berman, B. (1997) Teledermatology and underserved populations. *Archives of Dermatology.* 133, 197-200.

Oakley, A., Astwood, D.R., Loane, M., Duffill, M.B., Rademaker, M., Wootton, R. (1997) Diagnostic accuracy of teledermatology: Results of a preliminary study in New Zealand. *New Zealand Medical Journal.* 110,51-53.

Oakley, A.M.M., Laske, J.M., Duffil, M.B., Rademaker, M. (1998) Interactive teledermatology in practice. *British Journal of Dermatology.* 139, suppl 51,67.

Ovenden, R. (1997) John Thompson M.P. (1837-1921). Photographer. *National Library of Scotland, The Stationary Office, Edinburgh.*

Palmer, D (2000) John Ruskin (1890 - 1900), Man of Art and Science. *Nature 403, 830.*

Parrish, L.C., Worden, G., Witkowski, J.A., Scholz, A., Parish, D. H. (1991) Wax models and dermatology. *Transactions and studies of the College of Physicians of Philadelphia.* 13,29-74.

Perednia, D.A. (1991) What dermatologists should know about digital imaging. *Journal of the American Academy of Dermatology.* 25,89-108.

Perednia, D.A., Brown, A. (1995) Teledermatology: one application of Telemedicine. *Bulletin of the Medical Library Association.* 83,42-47.

Perednia, D.A., Gaines, J.A., Butruille, T. (1995) Comparison of the clinical informativeness of photographs and digital imaging media, with multiple-choice receiver operating characteristic analysis. *Archives of Dermatology.* 131,292-297.

Perednia, D.A., Gaines, J.A., Rossum, A.C. (1992) Variability in Physicians Assessment of Lesions in Cutaneous Images and its Implications of Skin Screening and Computer Assisted Diagnosis. *Archives of Dermatology.* 128,357-364.

Piccolo, D., Smolle, J., Wolf, I., Peris, K., Hofmann-Wellenhof, R., Dell'Eva, G., Burroni, M., Chimeni, S., Kerl, H., Soyer, P. (1999) Face to face diagnosis Vs telediagnosis of pigmented skin tumours. A teledermoscopic study. *Archives of Dermatology* 135 1467-1471.

Phillips, C.M., Burke, W.A., Allen, M.H., Stone, D., Wilson, J.L. (1998) The reliability of telemedicine in evaluating skin tumours. *Telemedicine Journal.* 4,5-9.

Piccolo, D., Smolle, J., Chimenti, S., Gafrini, F. (1999) Teledermoscopy - a multicentric study on pigmented skin tumours. *6th Congress of the International Society for Skin Imaging, London.*

Pissard, H.G. (1891) The practical treaties on diseases of the skin. *Lewis, London.*

Preston, J., Brown, F.W., Hartley, B. (1992) Using telemedicine to improve health care in distant areas. *Hospital Communications in Psychiatry.* 43,25-32.

Pringle, J.J. (1904) A pictorial atlas of skin diseases and syphilitic affections. *Rebman, London.*

Provost, N., Kopf, A.W., Rabinovitz, H.S., Stolz, W., DeDavid, M., Wasti, Q., Bart, R.S. (1998) Compressed of conventional photographs and telephonically transmitted compress digitized images of melanomas and dysplastic naevi. *Dermatology* 196 299-304.

Radcliffe-Crocker, H.R. (1893, 1896) Atlas of diseases of the skin in a series of illustrations from original drawings with descriptive letterpress. *Pentland, Edinburgh & London.*

Ramsey, D.L., Benimorff, F. (1981) The ability of primary care physicians to recognise the common dermatoses. *Archives of Dermatology.* 117,620-622.

Rayer, P. (1835) Atlas of diseases of the skin. *Bailliere, London.*

Riley. C.L. (1995) Colour codes. Modern theories of colour in philosophy, painting and architecture, literature, music and psychology. *University Press of New England, Hanover.*

Ritchie, C. (1998) British army establishes telemedicine unit in Bosnia. *Lancet.* 352,46.

Robinson, N. (1999) NHS Direct - "Gateway to the NHS"? *British Journal of Health Care Computing and Information Management.* 16,25-26.

Rogers, B.O., Rhode, M.G. (1995) The first civil war. Photographs of soldiers with facial wounds. *Aesthetic plastic surgery.* 19,269-283.

Ruskin, J. (1864) Selections from the writings of John Ruskin. Painting and painters, pg 109. *Smith, Elder & Co. London.*

Ruskin, J. (1893a) Selections from the writings of John Ruskin. Characteristics of nature, pg 75. *Smith, Elder & Co., London.*

Ruskin, J. (1893b) Selections from the writings of John Ruskin. Library Edition. Vol III. Modern painters Vol II, section 1, pg 224. *G. Allen, London.*

Ruskin, J. (1903a) The works of Ruskin. Library Edition. Vol VIII. The seven lamps of architecture: preface to the second edition, pg 13. *G. Allen, London.*

Ruskin, J. (1903b) The works of Ruskin. Library Edition. Vol III. Modern painters Vol I. Preface to the second edition, pg 37. *G. Allen, London.*

Ruskin, J. (1903c) The works of Ruskin. Library Edition. Vol III Modern painters Vol I. Painting and poetry, pg 171. *G. Allen, London.*

Ruskin, J. (1904) The works of Ruskin. Library Edition. Vol X. Stones of Venice Vol II, Pg 108. *G. Allen, London.*

Sasson, M., Schiff, T., Stiller, M.J. (1994) Photography without film; Low cost digital cameras come of age in dermatology. *International Journal of Dermatology.* 33,113-115.

Sibson 1999 A skin cancer screening study using telemedicine. *Journal of Telemedicine and Telecare.* 5, suppl,132.

Skin cancer in the North West (1994) Report by the Public Health Resource Centre for Cancer Epidemiology. *Christie Hospital, Manchester.*

Slue, W.E., Paglialunga, A., Neville, J., Stiller, M.J. (1993) Snapshots versus medical photographs: Understanding the difference is your key to better dermatologic office photography. *Cutis.* Vol 51, 345-347.

Sneiderman, C., Hood, A. (1991) A comparison of video and photographic display of skin lesions for morphology recognition. *JBC* vol.18, no.4. 22-25.

Sneiderman, C., Schosser, R., Pearson, T.G. (1994) A comparison of JPEG and TIFF compression of colour medical images for dermatology. *Computerised Medical Imaging and Graphics.* 339-342

.

Sosa-Iudicissa, M., Wootton, R., Ferrer-Roca, O., (1998) History of telemedicine. In: Handbook of Telemedicine, editied by Ferrer-Roca, O & Sosa-Iudsicissa, M, *IOS Press, Amsterdam.*

Squire, B. (1878) Atlas of the diseases of skin. *Churchill, London.*

Stanbrey, B. (1999) Legal and ethical issues. In: European Telemedicine. Edited by Wootton, R. *Kensington Publications, London.*

Tait, C.P., and Clay, C.D. (1999) Pilot study of store-and-forward teledermatology services in Perth, Western Australia. *Australasian Journal of Dermatology* 40, 190-193.

Taylor, P., Goldsmith, P., Murray, K., Harris, D., Barkley, A. (2001) Evaluating a telemedicine system to assist in the management of dermatology referrals. *British Journal of Dermatology.* 144, 328-333

Taylor, R.W. (1889) A clinical atlas of venereal and skin diseases including diagnosis, prognosis and treatment. *Lea Brothers & Co., Philadelphia.*

Telemedicine and Telecare Project. (1998) Telemedicine and telecare: impact on health care. *Institute of Health Services Management, London.*

Times, The. (1999) A century in photographs.

Turner, D. (1712) De morbis cutaneis. The treaties of disease incident to the skin in two parts. *London.*

Unna, P.G., Morris, M., Duhring, L.A., Le Loir, H. (1889) International atlas of rare skin diseases. *Hamburgh.*

Van De Venter, J. (1906) Atlas of cutaneous morbid histology. *Archibald Constable, London*

Vassallo, E.J., Bookson, P.J., Kilbey, K. (1998) The first telemedicine link for the british forces. *J.R. Army Med Core.* 144, 125-130.

Wallace, A.F. (1985) The early history of clinical photography for burns, plastic and reconstructive surgery. *British Journal of Plastic Surgery.* 38, 451-465.

Wallace, S. (1999) Telemedicine in the NHS for the millennium and beyond. *Institute for Public Policy R*esearch, *London.*

Wallace, S., Wyatt, J., Taylor, P. (1998) Telemedicine in the NHS for the millennium and beyond. *Post Graduate Medical Journal.* 74,721-728.

Warburton, R.N. (1991) Digital imaging at a community hospital: Implications for hospital stays and teleradiology. *International Journal of Biomedical Computing.* 28, 169-180.

White, H. (1999) The Cornwall dermatology electronic referral and image transfer project. *Journal of Telemedicine and Telecare* 5, suppl, 85-86.

White, R. (1995a) Discovering old cameras, 1839-1939. *Shire publications, Princes Risborough.*

White, R. (1995b) Discovering cameras, 1945-1965. *Shire publications, Princes Risborough.*

Whited, J.D., Hall, R.P., Simel, D.L., Foy, M.E., Stechuchak, K.M., Drugge, R.J., Grichnik, J.M., Myres, S.A., Horner, R.D. (1999) Reliability and accuracy of dermatologists' clinic-based and digital image consultantions. Journal of the American Academy of Dermatology. 41: 693-702.

Wilcox, L.A., Grimwood, R.E. (1995) A Comparative Study of Original Images versus 35mm Images. *Military Medicine.* 160, 470-2.

Willan, R. (1798, 1808) Description and treatment of cutaneous diseases. *J. Johnstone. London.*

Williams, A.R.A. (1982) Victorian clinical photography. *Journal of Audio Visual Media in Medicine.* 5, 100-103.

Wilson, E. (1847) Portraits of diseases of the skin. *Churchill, London.*

Wong, C.S., Taylor, F., Harrison, P.V., Yates, V.M. (2000) Does teledermatology have a role in managing waiting lists for patients with benign and malingnant skin tumours. *British Journal of Dermatology,* in press.

Woodville, W.(1793) Medical botany, containing...descriptions with plates, of all medicinal plants...in the catalogues of the materia medica...*Phillips, London.*

Wootton, R. (1996) Telemedicine: A cautious welcome. *British Medical Journal.* 313,1375-1377.

Wootton, R. (1998a) Telemedicine: An introduction. In: European Telemedicine, edited by Wootton,R. *Kensington Publications, London.*

Wootton, R. (1998b) Telemedicine in the National Health Service. *Journal of the Royal Society of medicine.* 91,614-621.

Wootton, R., Loane, M. (1998) Teledermatology. In: Handbook of Telemedicine, edited by Ferrer-Roca, O & Sosa-Iudicissa, M. *IOS Press, Amsterdam.*

Young, W.H. (1995) Kodachrome - a brief history and introduction to the film and process. *Journal of Biological Photography.* 63, 87-90.

Yamamoto, L.G.(1995) Using JPEG image compression to facilitate telemedicine. *American Journal of Emergency Medicine.* 13, 55-57.

Yule, W.L. (1998) The search for the medical artist. *Lancet.* 352, 806-809.

Figure R1. Trees on hillside. Canon EF camera, Canon 35-75mm lens, Kodachrome film ASA 25, shutter speed 1/60, aperture f11.

APPENDICES

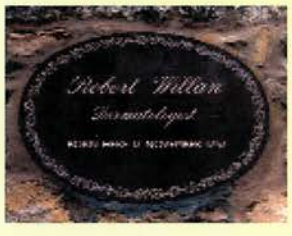
APPENDIX 1

THE LANCASTER DERMATOLOGY DEPARTMENT

The National Health Service (NHS) began in 1948 and this was also the start of dermatology, or the practice of dealing with skin diseases, in Lancaster. Although dermatology is now a separate speciality within medicine, this was not always so. Skin diseases have been recognised for a long time, indeed leprosy was known about in ancient times, and so too were a number of skin conditions. However, it is only more recently that the causes of many skin problems have been understood and now we have a wide range of treatments available.

The real classification of skin problems began in the 18th Century, but in the early 19th Century, Robert Willan, whose family came from near Sedbergh, wrote and illustrated one of the earliest textbooks in English on dermatology.

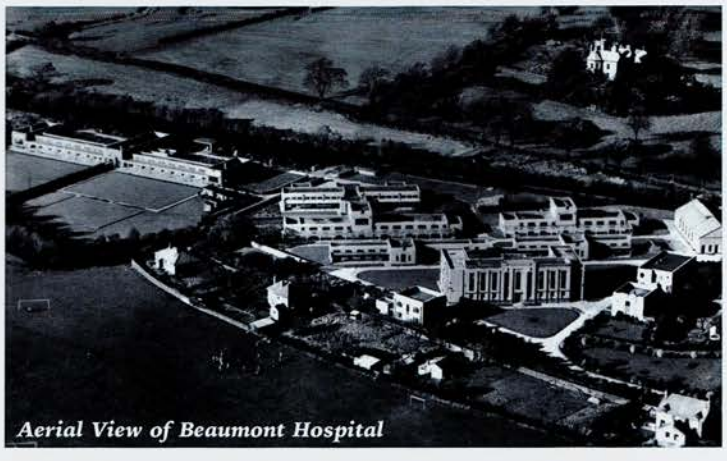
The plaque on Robert Willan's House



Robert Willan (1757-1812)

Although skin problems in Lancaster has been dealt with prior to 1948, it was the introduction of the NHS that enabled skin diseases to be dealt with in more co-ordinated manner in Lancaster. In 1953, the first Consultant Dermatologist in Lancaster, started work and soon designated dermatology beds were available and a skin unit was formed at Beaumont Hospital, Lancaster.

Beaumont Hospital opening in 1938



Aerial View of Beaumont Hospital

Developments came with different treatments, and soon facilities such as UV light, and a minor operating theatre were part of dermatology.

A teaching room, on the ENT ward (adjacent to the dermatology unit). An identical room above the dermatology ward, Beaumont Hospital, was the first skin office.

A replacement Consultant Dermatologist was appointed in 1980 and closure of Beaumont Hospital in 1990, led to the relocation of the Dermatology Unit at the Queen Victoria Hospital, Morecambe. This enabled the co-ordination of the service with combined in-patient and outpatient units and development of the day case treatments.

The inclusion of dermatology in the local general practitioner training scheme has meant that to present 38 senior house officer doctors have been attached to the unit, many of whom have gone on to become general practitioners, and some of these have also maintained experience in dermatology by becoming clinical assistant doctors.

Victoria House, former nurses home, Queen Victoria Hospital, Morecambe.

Developments in the service have included a registrar doctor rotation with Manchester from 1996, and various research links including the University of Lancaster, and the University College of St Martins.

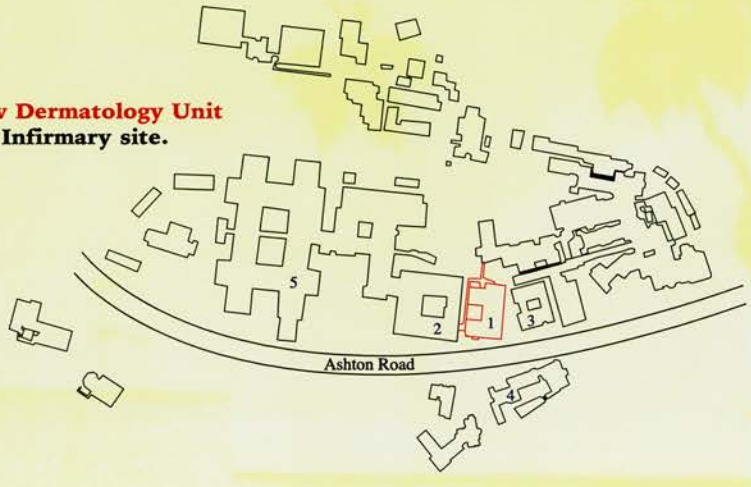
Dermatology outpatient facilities were enhanced in Kendal with the opening of Westmorland General Hospital, and outpatients facilities have also continued at Furness General Hospital, Barrow.

Inventory Book for the Queen Victoria Hospital, Morecambe in 1935.

(Background) The Nurses Home, Beaumont Hospital c1934

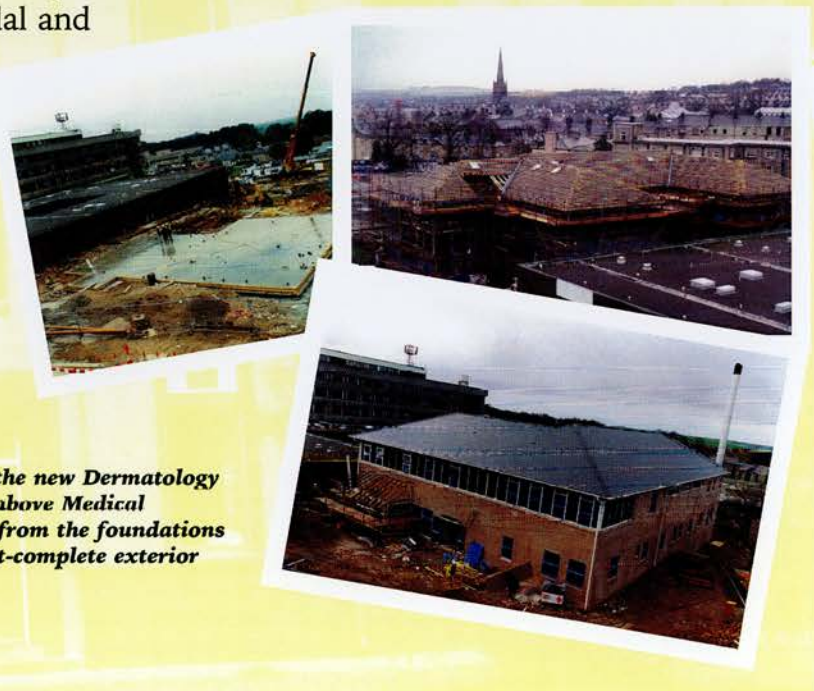
Plans were developed in 1995 to move the dermatology department to the Royal Lancaster Infirmary site. It was decided to design a purpose built department above the new medical outpatients.

The location of the New Dermatology Unit on the Royal Lancaster Infirmary site.



1. Dermatology Unit
2. Maternity Clinic
3. Ashton Road Clinic
4. Springville House
5. Centenary Building

Another Consultant retirement in 1997 led to a further consultant appointment, and now the two consultants equally cover the three hospital sites, Lancaster, Kendal and Barrow. Dermatology is now a Morecambe Bay speciality, covering approximately a population of 350,000 people.



Progress of the new Dermatology Unit, based above Medical Outpatients from the foundations to the almost-complete exterior

The new department, opened in 1998, has 12 beds, enhanced integral outpatient facilities, UV light treatment, minor operating and day case facilities. Dedicated dermatology nurses, an important aspect of skin management, enables the treatment of a wide variety of skin problems.

Bandage Dressings & treatments have changed since this first field dressing in 1943.

Ointment for skin problems in 1932

50 years of dermatology and the NHS have seen many changes and we are now at an exciting stage, approaching the millennium when the background to many skin diseases is being unravelled. We already have many more treatments available than we did 50 years ago, and as our understanding improves, so our ability to treat more and more skin problems will be enhanced. The new dermatology unit in Lancaster is an important development in the service, and is here to improve the care of skin problems for the Morecambe Bay population.

(Background) Aerial View of Beaumont Hospital

APPENDIX 2

PHOTOGRAPHIC DIAGNOSIS COMPARED WITH HISTOLOGICAL DIAGNOSIS (3RD DATA ANALYSIS OF 164 PATIENTS)

Sex	Age	General Practitioner Diagnosis	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
F	54	Lentigo	Actinic keratosis	Actinic keratosis	Agree
M	48	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	56	Squamous cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	29	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	29	None indicated	Seborrhoeic wart	Seborrhoeic wart	Agree
F	21	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	70	Actinic keratosis	Squamous cell carcinoma	Basal cell carcinoma	Disagree
M	87	Cutaneous horn	Squamous cell carcinoma	Squamous cell carcinoma	Agree
M	87	None indicated	Seborrhoeic wart	Seborrhoeic wart	Agree
M	62	None indicated	Basal cell carcinoma	Basal cell carcinoma	Agree
M	63	Seborrhoeic wart	Actinic keratosis	Actinic keratosis	Agree
F	49	Benign melanocytic naevus	Benign melanocytic naevus	Seborrhoeic wart	Disagree
M	74	Basal cell carcinoma	Actinic keratosis	Actinic keratosis	Agree
F	62	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	34	Sebaceous cyst	Sebaceous cyst	Sebaceous cyst	Agree
F	47	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	73	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	96	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	71	Melanoma	Blue naevus	Cavernous haemangioma	Disagree
M	35	Benign cyst	Basal cell carcinoma	Basal cell carcinoma	Agree
F	37	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	14	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	67	None indicated	Actinic keratosis	Solar elastosis	Disagree
M	49	Benign warty lesion	Squamous cell carcinoma	Squamous cell carcinoma	Agree
F	73	Actinic keratosis	Squamous cell carcinoma	Squamous cell carcinoma	Agree
M	37	Papilloma	Squamous papilloma	Squamous papilloma	Agree
M	65	Seborrhoeic wart	Seborrhoeic wart	Seborrhoeic wart	Agree
M	21	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree

APPENDIX 2 continued

Sex	Age	General Practitioner Diagnosis	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
F	43	Benign fibroma	Dermatofibroma	Dermatofibroma	Agree
M	43	Basal cell carcinoma	Basal cell carcinoma	Solar elastosis	Disagree
F	44	Benign papilloma	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	83	Keratoacanthoma	Squamous cell carcinoma	Seborrhoeic warts	Disagree
F	62	Seborrhoeic warts	Seborrhoeic wart	Seborrhoeic wart	Agree
M	65	Seborrhoeic warts	Seborrhoeic warts	Seborrhoeic warts	Agree
F	30	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	24	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	85	Seborrhoeic wart	Squamous cell	Seborrhoeic wart	Disagree
M	47	Basal cell carcinoma	Actinic keratosis	Actinic keratosis	Agree
M	8	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	27	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	21	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	67	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	55	Actinic keratosis	Actinic keratosis	Actinic keratosis	Agree
M	53	Benign pigmented lesion	Seborrhoeic wart	Seborrhoeic wart	Agree
F	80	Seborrhoeic wart	seborrhoeic wart	Sebaceous adenoma	Disagree
F	57	None indicated	Basal cell carcinoma	Basal cell carcinoma	Agree
F	55	Basal cell carcinoma	Bowen's disease	Seborrhoeic keratosis	Disagree
F	88	Basal cell carcinoma	Squamous cell carcinoma	Squamous cell carcinoma	Agree
F	64	Benign pedunculated lesion	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	34	Benign papilloma	Benign wart	Benign melanocytic naevus	Disagree
F	29	Benign wart	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	51	Benign wart	Basal cell carcinoma	Basal cell carcinoma	Agree
F	45	Dermatofibroma	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	66	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	63	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree

APPENDIX 2 continued

Sex	Age	General Practitioner Diagnosis	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
F	16	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	71	Bowen's disease	Bowen's disease	Bowen's disease	Agree
F	34	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	51	None indicated	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	66	Benign melanocytic naevus	Seborrhoeic wart	Seborrhoeic wart	Agree
F	67	Lentigo maligna	Lentigo maligna	Lentigo maligna	Agree
M	72	Squamous cell carcinoma	Actinic keratosis	Actinic keratosis	Agree
M	49	Benign melanocytic naevus	Benign freckle	Actinic keratosis	Disagree
F	66	Actinic keratosis	Actinic keratosis	Actinic keratosis	Agree
M	57	Squamous cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	58	Benign melanocytic naevus	Basal cell carcinoma	Non specific	Disagree
F	32	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	12	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	17	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	38	Benign melanocytic naevus	Simple lentigo	Solar elastosis	Disagree
F	83	Non specific ulcer	Granulation tissue	Squamous cell carcinoma	Disagree
M	70	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	59	Actinic keratosis	Squamous cell carcinoma	Basal cell carcinoma	Disagree
F	33	Benign melanocytic naevus	Benign wart	Epidermal naevus	Disagree
F	75	None indicated	Actinic keratosis	Actinic keratosis	Agree
M	48	Squamous papilloma	Squamous papilloma	Benign melanocytic naevus	Disagree
F	91	Keratoacanthoma	Actinic keratosis	Actinic keratosis	Agree
M	56	Senile lentigo	Actinic keratosis	Seborrhoeic wart	Disagree
F	34	None indicated	Adnexal tumour	Benign melanocytic naevus	Disagree
F	35	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	47	None indicated	Bowen's disease	Bowen's disease	Agree

APPENDIX 2 continued

Sex	Age	General Practitioner Diagnosis	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
M	88	Basal cell carcinoma	Basal cell carcinoma	Seborrhoeic wart	Disagree
F	53	Viral wart	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	43	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	45	None indicated	Squamous cell carcinoma	Benign melanocytic naevus	Disagree
M	28	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	16	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	66	None indicated	Squamous cell carcinoma	Squamous cell carcinoma	Agree
M	57	Squamous cell carcinoma	Actinic keratosis	Actinic keratosis	Agree
F	66	None indicated	Melanoma	Melanoma	Agree
F	79	None indicated	Adnexal tumour	Basal cell carcinoma	Disagree
F	54	Benign melanocytic naevus	Basal cell carcinoma	Basal carcinoma	Agree
M	61	Actinic keratosis.	Actinic keratosis.	Actinic keratosis.	Agree
F	41	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	72	Basal cell carcinoma	Squamous cell carcinoma	Squamous cell carcinoma	Agree
M	74	Basal cell carcinoma	Squamous cell carcinoma	Actinic keratosis	Disagree
M	42	Benign Wart	Benign melanocytic naevus	Squamous papilloma	Disagree
F	20	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	62	Seborrhoeic wart	Seborrhoeic wart	Seborrhoeic wart	Agree
F	27	None indicated	Benign unspecified lesion	Benign melanocytic naevus	Disagree
M	82	None indicated	Chondrodermatitis nodularis helicis	Actinic Keratosis	Disagree
F	14	None indicated	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	54	Benign melanocytic naevus	Basal cell carcinoma	Blue naevus.	Disagree
F	51	None indicated	Dermatofibroma.	Dermatofibroma.	Agree
M	60	None indicated	Actinic keratosis	Actinic keratosis	Agree
F	87	Basal cell carcinoma	Basal cell carcinoma	Squamous cell carcinoma	Disagree
F	46	None indicated	Bowen's disease	Basal cell carcinoma	Disagree
F	68	None indicated	Squamous cell carcinoma	Squamous cell carcinoma	Agree

APPENDIX 2 continued

Sex	Age	General Practitioner Diagnosis	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
F	26	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	67	Bowen's disease.	Squamous cell carcinoma	Bowen's disease	Disagree
M	60	Benign melanocytic naevus	Seborrhoeic wart	Seborrhoeic wart	Agree
F	42	Benign melanocytic naevus	Benign melanocytic naevus	Dermatofibroma	Disagree
M	39	Benign melanocytic naevus	Benign melanocytic naevus	Seborrhoeic wart	Disagree
F	19	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	61	Actinic keratosis	Actinic keratosis	Actinic keratosis	Agree
F	81	Squamous cell carcinoma	Seborrhoeic wart	Seborrhoeic wart	Agree
M	55	Squamous cell carcinoma	Squamous cell carcinoma	Basal cell carcinoma	Disagree
M	78	Benign lentigo	Benign melanocytic naevus	Seborrhoeic wart	Disagree
F	56	Benign wart	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	79	Bowen's disease.	Bowen's disease.	Bowen's disease	Agree
F	69	Non indicated	Benign melanocytic naevus	Pilomatrixoma	Disagree
F	91	Basal cell carcinoma	Chondrodermatitis nodular helicis	Actinic keratosis	Disagree
M	70	None indicated	Adnexal tumour	Trichofolliculoma	Agree
F	26	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	42	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	89	None indicated	Basal cell carcinoma	Basal cell carcinoma	Agree
M	57	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	74	None indicated	Seborrhoeic wart	Seborrhoeic wart	Agree
F	81	Basal cell carcinoma.	Squamous cell carcinoma.	Squamous cell carcinoma	Agree
F	83	Bowen's disease	Seborrhoeic wart	Solar elastosis	Disagree
F	60	Squamous cell carcinoma	Squamous cell carcinoma	Seborrhoeic wart	Disagree
M	47	Benign wart	Seborrhoeic wart	Seborrhoeic wart	Agree
F	88	Actinic keratosis.	Squamous cell carcinoma.	Squamous cell carcinoma	Agree

APPENDIX 2 continued

Sex	Age	General Practitioner Diagnosis	Photographic Diagnosis	Histological Diagnosis	Agree/ Disagree
M	79	Actinic keratosis	Actinic keratosis	Actinic keratosis	Agree
F	20	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
F	59	Seborrhoeic wart	Seborrhoeic wart	Seborrhoeic wart	Agree
F	73	Benign wart	Seborrhoeic wart	Seborrhoeic wart	Agree
F	88	Basal cell carcinoma.	Basal cell carcinoma.	Basal cell carcinoma	Agree
F	89	None indicated	Squamous cell carcinoma	Squamous cell carcinoma	Agree
M	76	Chondrodermatitis nodularis helicis.	Squamous cell carcinoma.	Squamous cell carcinoma	Agree
F	77	Bowen's disease	Bowen's disease	Bowen's disease	Agree
F	26	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Disagree
F	51	None indicated	Actinic keratosis	Actinic keratosis	Agree
M	66	None indicated	Haemangioma	Pyogenic granuloma	Disagree
F	66	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	88	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	36	Benign melanocytic naevus	Non specified	Benign melanocytic naevus	Disagree
F	11	Benign melanocytic naevus	Benign melanocytic naevus	Squamous papilloma	Disagree
M	87	Cutaneous horn.	Squamous cell carcinoma	Squamous cell carcinoma	Agree
M	53	None indicated	Squamous cell carcinoma	Basal cell carcinoma	Disagree
M	76	Basal cell carcinoma	Basal cell carcinoma	Actinic keratosis	Disagree
F	64	Seborrhoeic wart	Seborrhoeic wart	Seborrhoeic wart	Agree
F	67	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
F	68	Seborrhoeic wart	Seborrhoeic wart	Seborrhoeic wart	Agree
M	73	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	59	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	24	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	33	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	44	Haemangioma	Haemangioma	Haemangioma	Agree
F	32	Benign melanocytic naevus	Benign melanocytic naevus	Benign melanocytic naevus	Agree
M	59	Basal cell carcinoma	Basal cell carcinoma	Basal cell carcinoma	Agree
M	62	Basal cell carcinoma	Basal cell carcinoma	Squamous cell carcinoma	Disagree
F	50	None indicated	Basal cell carcinoma	Basal cell carcinoma	Agree
F	30	None indicated	Actinic keratosis.	Actinic keratosis.	Agree
Age range 8 years – 96 years Diagnostic accuracy = 75%			Number of females = 100 Number of males = 64	Mean age 55 years	

APPENDIX 3

ASSESSMENT OF PATIENTS ATTENDING CONVENTIONAL PHOTOGRAPHIC IMAGING AT LANCASTER, KENDAL AND BARROW

DERMATOLOGY SKIN IMAGING

This is a new service in the Dermatology Department and we would like to know the views of patients using it. We would be grateful if you could spare a few minutes to fill in the following questionnaire. All answers are confidential. Please answer with a ☒ in the appropriate box.

No.	Q1 Are you: Male ☐ Female ☐	Q2 Age ☐

Q3
Would you prefer to have been seen in the Dermatology Clinic first?
YES ☐ NO ☐ NO OPINION ☐

Q4
Did you prefer to be seen in the Imaging clinic in the Medical Illustration Dept. instead of the Dermatology Clinic?
YES ☐ NO ☐ NO OPINION ☐

Q5
Did the fact that the clinic was organised to enable images to be taken of your skin, stop you from mentioning any other lesions you may have?
YES ☐ NO ☐ DID NOT HAVE ANY ☐

Q6
Compared to hospital clinic visits, did you think this service is:
BETTER ☐ SAME ☐ WORSE ☐

Q7
If you feel the service is either better or not as good please state why

Q8
Did you find any problems with the service?
YES ☐ NO ☐

Q9
If YES, what problems did you have?

Q10
If you have any comments, please add them here

APPENDIX 3 continued

Q10

Before you were sent for, to attend the clinic at Medical Illustration, how long had you been on the Dermatology waiting list? Was it:

less than 1 month	☐	3-6 months	☐
7-9 months	☐	10-12 months	☐
13-18 months	☐	more than 18 months	☐

Q11

If more than 18 months please say how long: ☐☐ months

Q12

For many people the Skin Imaging service will mean quicker treatment and save a visit to the Dermatology Department. How happy are you to have your treatment decided by a doctor looking at the image rather than by seeing you in person?

Very Happy ☐ Quite Happy ☐ Indifferent ☐ Unhappy ☐ Very Unhappy ☐

Q13

If you have any comments on the service, please add them here:

APPENDIX 4

No.	Lancaster, Kendal or Barrow	Sex	Age	Prefer a dermatology visit first	Prefer medical illustration first	Other lesion	Was photo-graphic service quick and efficient
1	Lancaster	F	35	DM	Y	N	Y
2	Lancaster	F	33	DM	DM	N	Y
3	Lancaster	M	59	DM	N	N	Y
4	Lancaster	M	47	N	Y	Y	NC
5	Lancaster	F	21	DM	DM	N	Y
6	Lancaster	F	75	N	Y	N	NC
7	Lancaster	F	44	N	Y	N	NC
8	Lancaster	F	60	DM	DM	N	Y
9	Lancaster	M	66	N	Y	N	N
10	Lancaster	F	79	N	Y	N	NC
11	Lancaster	F	47	N	Y	N	Y
12	Lancaster	M	22	DM	DM	N	Y
13	Lancaster	M	8	DM	Y	Y	Y
14	Lancaster	M	31	Y	DM	N	NC
15	Lancaster	M	13	DM	Y	N	Y
16	Lancaster	F	40	DM	DM	N	Y
17	Lancaster	F	62	N	Y	N	NC
18	Lancaster	F	14	DM	DM	N	NC
19	Lancaster	F	57	N	Y	N	Y
20	Lancaster	M	59	DM	N	N	NC
21	Lancaster	F	76	Y	N	N	NC
22	Lancaster	F	71	N	Y	N	NC
23	Lancaster	F	42	N	N	Y	Y
24	Lancaster	F	35	DM	Y	N	NC
25	Lancaster	M	59	DM	DM	N	NC
26	Lancaster	F	52	N	Y	N	Y
27	Lancaster	F	76	N	N	N	Y
28	Lancaster	F	76	N	N	N	NC
29	Lancaster	M	45	N	DM	N	Y
30	Lancaster	F	62	N	Y	N	Y
31	Lancaster	M	64	DM	DM	Y	NC
32	Lancaster	M	94	N	Y	N	Y
33	Lancaster	F	44	Y	N	N	NC
34	Lancaster	F	24	N	Y	N	Y
35	Lancaster	F	56	N	Y	N	NC
36	Lancaster	M	54	N	Y	N	NC
37	Lancaster	F	20	N	Y	N	Y

APPENDIX 4 continued

No.	Lancaster, Kendal or Barrow	Sex	Age	Prefer a dermatology visit first	Prefer medical illustration first	Other lesion	Was photo-graphic service quick and efficient
38	Lancaster	F	67	DM	Y	N	Y
39	Lancaster	M	52	DM	DM	N	Y
40	Lancaster	M	26	DM	DM	N	Y
41	Lancaster	M	7	N	Y	N	NC
42	Lancaster	M	17	DM	DM	Y	Y
43	Lancaster	M	50	DM	DM	N	Y
44	Lancaster	F	16	N	Y	N	Y
45	Lancaster	F	51	N	Y	N	NC
46	Lancaster	F	32	DM	DM	N	Y
47	Lancaster	F	23	DM	DM	N	NC
48	Lancaster	F	8	N	N	N	NC
49	Lancaster	F	84	N	DM	N	Y
50	Lancaster	F	29	N	DM	N	NC
51	Lancaster	F	43	N	Y	N	Y
52	Lancaster	F	40	N	Y	N	NC
53	Lancaster	M	42	DM	Y	N	Y
54	Lancaster	F	42	DM	Y	N	Y
55	Lancaster	M	20	N	Y	N	NC
56	Lancaster	F	60	Y	DM	N	Y
57	Lancaster	M	64	DM	DM	N	Y
58	Lancaster	F	43	DM	DM	N	Y
59	Lancaster	F	83	N	DM	N	Y
60	Lancaster	M	64	DM	DM	N	Y
61	Lancaster	F	72	N	DM	N	Y
62	Lancaster	F	61	N	Y	N	Y
63	Lancaster	F	25	DM	DM	N	NC
64	Lancaster	M	36	DM	DM	N	NC
65	Lancaster	F	72	DM	Y	N	Y
66	Lancaster	F	32	DM	DM	N	Y
67	Lancaster	M	58	DM	DM	N	Y
68	Lancaster	M	64	DM	DM	N	NC
69	Lancaster	F	53	DM	N	Y	Y
70	Lancaster	M	70	Y	N	N	Y
71	Lancaster	M	13	DM	DM	N	Y
72	Lancaster	F	43	DM	Y	N	Y
73	Lancaster	F	36	DM	DM	N	Y
74	Lancaster	F	49	N	DM	N	Y
75	Lancaster	M	34	N	DM	N	Y
76	Lancaster	M	70	DM	DM	N	NC
77	Lancaster	F	33	Y	N	N	NC
78	Lancaster	F	67	N	Y	N	Y
79	Lancaster	F	95	N	Y	N	NC
80	Lancaster	F	61	N	Y	N	Y

APPENDIX 4 continued

No.	Lancaster, Kendal or Barrow	Sex	Age	Prefer a dermatology visit first	Prefer medical illustration first	Other lesion	Was photo-graphic service quick and efficient
81	Lancaster	M	73	N	N	N	Y
82	Lancaster	F	59	Y	N	N	Y
83	Lancaster	M	72	N	DM	N	Y
84	Lancaster	F	81	Y	Y	N	NC
85	Lancaster	F	46	N	DM	N	NC
86	Lancaster	F	52	DM	DM	N	NC
87	Lancaster	F	55	DM	DM	N	NC
88	Lancaster	F	15	N	Y	N	Y
89	Lancaster	F	20	Y	DM	Y	NC
90	Lancaster	F	54	N	Y	N	Y
91	Lancaster	F	51	DM	DM	N	NC
92	Lancaster	M	47	Y	N	N	NC
93	Lancaster	F	29	DM	Y	N	Y
94	Lancaster	F	56	N	DM	N	Y
95	Lancaster	M	74	N	Y	N	NC
96	Lancaster	M	63	N	Y	N	NC
97	Lancaster	M	87	DM	N	N	NC
98	Lancaster	M	61	DM	DM	N	Y
99	Lancaster	M	69	DM	DM	N	Y
100	Lancaster	F	69	N	DM	N	NC
101	Lancaster	M	62	N	Y	N	NC
102	Lancaster	F	36	DM	DM	N	NC
103	Lancaster	F	22	DM	DM	N	Y
104	Lancaster	F	11	DM	Y	N	NC
105	Lancaster	F	16	N	Y	N	Y
106	Lancaster	F	37	DM	DM	N	Y
107	Lancaster	F	82	N	Y	N	NC
108	Lancaster	M	69	DM	DM	N	NC
109	Lancaster	F	23	DM	DM	N	Y
110	Lancaster	F	36	N	Y	N	NC
111	Lancaster	F	52	DM	DM	N	Y
112	Lancaster	F	65	DM	DM	N	NC
113	Lancaster	F	57	N	Y	N	Y
114	Lancaster	M	46	DM	DM	N	NC
115	Lancaster	M	66	N	Y	N	NC
116	Lancaster	M	56	DM	DM	N	NC
117	Lancaster	M	79	N	Y	N	NC
118	Lancaster	M	47	Y	N	N	NC
119	Lancaster	M	70	DM	DM	N	NC
120	Lancaster	F	66	N	N	N	NC
121	Lancaster	F	14	DM	Y	N	NC
122	Lancaster	F	16	Y	DM	N	NC
123	Lancaster	F	64	DM	DM	N	Y

APPENDIX 4 continued

No.	Lancaster, Kendal or Barrow	Sex	Age	Prefer a dermatology visit first	Prefer medical illustration first	Other lesion	Was photo-graphic service quick and efficient
124	Lancaster	F	85	DM	N	N	NC
125	Lancaster	M	84	DM	Y	N	NC
126	Lancaster	F	52	DM	DM	N	Y
127	Lancaster	F	27	DM	DM	N	Y
128	Lancaster	F	69	N	N	N	Y
129	Lancaster	M	48	DM	DM	N	Y
130	Lancaster	M	13	N	Y	N	Y
131	Lancaster	F	56	DM	Y	N	Y
132	Lancaster	F	69	N	N	N	Y
133	Lancaster	F	66	N	Y	N	NC
134	Lancaster	F	36	Y	N	N	NC
135	Lancaster	F	65	DM	DM	N	Y
136	Lancaster	F	8	N	Y	N	NC
137	Lancaster	F	70	DM	DM	N	Y
138	Lancaster	F	33	DM	DM	N	Y
139	Lancaster	M	20	N	N	N	NC
140	Lancaster	F	50	DM	DM	N	NC
141	Lancaster	F	62	N	N	N	NC
142	Lancaster	F	15	N	Y	N	Y
143	Lancaster	F	44	Y	DM	Y	NC
144	Lancaster	F	55	DM	Y	N	Y
145	Lancaster	M	28	DM	DM	N	NC
146	Lancaster	F	34	N	Y	N	Y
147	Lancaster	M	50	Y	N	N	NC
148	Lancaster	F	74	N	Y	N	Y
149	Lancaster	F	80	DM	DM	N	Y
150	Lancaster	F	63	N	Y	N	NC
151	Lancaster	M	70	N	Y	N	Y
152	Lancaster	F	70	DM	Y	N	Y
153	Lancaster	F	56	DM	DM	N	Y
154	Lancaster	M	87	DM	N	N	NC
155	Lancaster	F	86	N	Y	N	NC
156	Lancaster	M	63	Y	N	N	NC
157	Lancaster	F	54	N	Y	N	Y
158	Lancaster	F	55	N	Y	N	Y
159	Lancaster	F	33	N	Y	N	Y
160	Lancaster	M	53	DM	Y	Y	Y
161	Lancaster	F	62	N	Y	N	NC
162	Lancaster	M	60	N	DM	N	Y
163	Lancaster	F	86	Y	N	N	NC
164	Lancaster	F	45	N	Y	N	Y
165	Lancaster	F	35	N	DM	N	Y
166	Lancaster	F	59	N	Y	N	NC

APPENDIX 4 continued

No.	Lancaster, Kendal or Barrow	Sex	Age	Prefer a dermatology visit first	Prefer medical illustration first	Other lesion	Was photo-graphic service quick and efficient
167	Lancaster	F	51	Y	N	N	Y
168	Lancaster	F	67	Y	N	N	NC
169	Lancaster	F	26	N	Y	N	Y
170	Lancaster	F	89	DM	DM	N	Y
171	Lancaster	F	93	N	Y	N	Y
172	Lancaster	F	61	N	DM	N	NC
173	Lancaster	F	19	DM	DM	N	Y
174	Lancaster	M	42	DM	DM	N	Y
175	Lancaster	F	66	Y	N	N	NC
176	Kendal	F	62	N	DM	N	Y
177	Kendal	F	58	N	DM	N	Y
178	Kendal	F	29	DM	DM	N	Y
179	Kendal	F	79	N	Y	N	Y
180	Kendal	F	35	DM	DM	N	Y
181	Kendal	F	76	N	Y	N	Y
182	Kendal	F	55	DM	DM	N	Y
183	Kendal	F	30	DM	N	N	Y
184	Kendal	F	86	Y	N	N	Y
185	Kendal	M	36	DM	DM	N	Y
186	Kendal	F	30	N	N	N	Y
187	Kendal	F	28	N	DM	N	Y
188	Kendal	M	68	DM	DM	N	Y
189	Kendal	M	38	Y	N	Y	Y
190	Kendal	F	74	N	Y	N	Y
191	Kendal	F	51	DM	DM	N	NC
192	Kendal	F	67	DM	DM	N	NC
193	Kendal	F	50	DM	N	Y	NC
194	Kendal	F	29	N	Y	N	Y
195	Kendal	F	32	N	Y	N	Y
196	Kendal	M	50	DM	DM	N	NC
197	Kendal	F	57	N	DM	N	NC
198	Kendal	M	13	DM	DM	N	NC
199	Kendal	F	58	DM	DM	N	NC
200	Kendal	F	70	N	Y	N	Y
201	Kendal	F	60	N	Y	N	Y
202	Kendal	F	71	DM	DM	N	NC
203	Kendal	F	64	N	Y	N	NC
204	Kendal	M	71	DM	DM	N	Y
205	Kendal	F	58	N	Y	N	Y
206	Kendal	F	93	DM	Y	N	Y
207	Kendal	F	55	N	Y	N	Y
208	Kendal	M	35	N	DM	N	Y
209	Kendal	F	75	DM	DM	N	Y

APPENDIX 4 continued

No.	Lancaster, Kendal or Barrow	Sex	Age	Prefer a dermatology visit first	Prefer medical illustration first	Other lesion	Was photo-graphic service quick and efficient
210	Kendal	M	55	N	Y	N	NC
211	Kendal	F	84	N	Y	N	Y
212	Kendal	M	37	Y	N	N	NC
213	Kendal	F	31	N	Y	N	Y
214	Kendal	M	77	DM	DM	N	Y
215	Kendal	M	29	N	N	N	Y
216	Kendal	F	16	DM	DM	N	NC
217	Kendal	F	61	N	DM	N	NC
218	Kendal	M	44	DM	DM	N	NC
219	Kendal	M	68	DM	DM	N	NC
220	Kendal	F	14	Y	N	N	N
221	Kendal	F	76	N	Y	N	Y
222	Kendal	F	63	Y	N	N	NC
223	Kendal	M	47	DMY	Y	N	NC
224	Kendal	F	66	DM	DM	N	Y
225	Kendal	F	73	N	DM	N	NC
226	Kendal	F	44	DM	DM	N	NC
227	Kendal	F	72	N	Y	N	Y
228	Kendal	F	54	DM	DM	N	NC
229	Kendal	F	25	DM	DM	N	NC
230	Kendal	F	47	DM	DM	N	Y
231	Kendal	F	81	N	N	N	NC
232	Kendal	M	74	DM	DM	N	NC
233	Kendal	F	57	Y	DM	N	NC
234	Kendal	F	32	DM	DM	Y	NC
235	Kendal	M	29	N	DM	N	Y
236	Kendal	F	56	DM	DM	Y	Y
237	Kendal	F	74	N	N	N	NC
238	Kendal	M	65	N	DM	N	NC
239	Kendal	M	60	DM	DM	N	Y
240	Barrow	F	36	Y	N	N	NC
241	Barrow	M	62	N	N	N	NC
242	Barrow	M	89	DM	DM	N	Y
243	Barrow	M	66	N	Y	N	Y
244	Barrow	F	57	Y	Y	N	NC
245	Barrow	F	41	N	DM	N	Y
246	Barrow	F	15	Y	N	N	NC
247	Barrow	M	70	DM	DM	N	NC
248	Barrow	F	76	NA	N	N	NC
249	Barrow	M	36	DM	DM	N	NC
250	Barrow	F	76	DM	N	N	NC
251	Barrow	F	26	N	Y	N	Y
252	Barrow	M	26	DM	DM	N	NC

APPENDIX 4 continued

No.	Lancaster, Kendal or Barrow	Sex	Age	Prefer a dermatology visit first	Prefer medical illustration first	Other lesion	Was photo-graphic service quick and efficient
253	Barrow	F	73	Y	N	N	NC
254	Barrow	F	73	DM	Y	N	NC
255	Barrow	F	55	N	Y	N	NC
256	Barrow	F	49	DM	DM	N	Y
257	Barrow	F	55	DM	N	N	NC
258	Barrow	F	55	Y	DM	N	NC
259	Barrow	F	48	Y	Y	N	NC
260	Barrow	M	62	N	Y	N	Y
261	Barrow	M	64	Y	Y	N	NC
262	Barrow	F	30	DM	DM	N	NC
263	Barrow	F	45	DM	DM	N	Y
264	Barrow	M	83	N	Y	N	NC
265	Barrow	F	27	DM	DM	N	NC
266	Barrow	F	65	Y	DM	N	NC
267	Barrow	M	19	Y	N	N	Y
268	Barrow	F	6	Y	N	N	NC
269	Barrow	M	62	DM	DM	N	Y
270	Barrow	F	63	DM	DM	N	Y
271	Barrow	F	10	DM	DM	N	NC
272	Barrow	M	81	DM	N	N	NC
273	Barrow	M	55	Y	N	N	NC
274	Barrow	M	52	Y	N	Y	NC
275	Barrow	F	68	N	Y	N	NC
276	Barrow	M	85	N	N	N	Y
277	Barrow	M	61	N	Y	N	Y
278	Barrow	M	56	DM	Y	N	Y
279	Barrow	F	14	N	Y	N	Y
280	Barrow	F	36	Y	DM	N	NC
281	Barrow	F	72	Y	Y	N	NC
282	Barrow	M	1	DM	N	N	NC
283	Barrow	F	23	Y	DM	N	NC
284	Barrow	F	5	NA	NA	N	NC
285	Barrow	M	66	Y	N	N	NC
286	Barrow	M	39	DM	DM	N	NC
287	Barrow	F	67	DM	DM	N	Y
288	Barrow	M	62	N	Y	N	Y
289	Barrow	F	72	DM	DM	N	Y
290	Barrow	F	79	Y	NA	N	NC
291	Barrow	M	69	DM	DM	N	NC

APPENDIX 4 continued

Table key

Preferred dermatology visit first
Y = yes. preferred dermatology clinic visit rather than medical illustration.
N = no. preferred visit to medical illustration
DM = didn't mind between visit to dermatology clinic or medical illustration

Preferred medical illustration first
Y = yes. preferred medical illustration visit rather than dermatology clinic visit
N = no. preferred dermatology clinic visit first
DM = don't mind between medical illustration or dermatology clinic visit

Other lesion
Y = yes. another lesion photographed, as well as the original referral
N = no other lesion photographed

Was photographic service quick & efficient
Y = yes. photographic service was quick and efficient
N = no. photographic service was not quick and efficient
DC = No comment

APPENDIX 5

FOLLOW-UP ASSESSMENT OF PATIENTS ATTENDING CONVENTIONAL PHOTOGRAPHIC IMAGING AT LANCASTER, KENDAL AND BARROW

DERMATOLOGY SKIN IMAGING

Following your visit to the Medical Illustration Dept for skin imaging, you have now attended the Dermatology Department for treatment and have been issued with a management plan based on the findings of the imaging. Your doctor will also have been informed of the results. We would like to know how our patients feel about this service, and would be grateful if you would fill in the following questionnaire. Please answer by placing a ☒ in the appropriate box.

No.

Q1
How long was the time lapse between the date you attended the Medical Illustration Department and today's treatment? Was it:

1 week ☐ 2 weeks ☐ 3 weeks ☐ 4 weeks ☐ more than 4 weeks ☐

Q2
Did you feel the management plan was helpful? Yes ☐ No ☐ No Opinion ☐

Q3
Did you feel that you received the management plan
Quickly ☐ Not quickly enough ☐ Not Sure ☐

Q4
Was today's treatment satisfactory? Yes ☐ No ☐ No Opinion ☐

Q5
If it was not satisfactory, please state why

Q6
Would you rather have been seen in the Dermatology Department?
Yes ☐ No ☐ No Opinion ☐

Q7
Would you be happy to attend a skin imaging service again if necessary?
Yes ☐ No ☐ No Opinion ☐

Q8
Compared to traditional hospital clinics did you feel that this service is:
Better ☐ Same ☐ Not as good ☐

Q9
If better or not as good please state why:

APPENDIX 5 continued

Q10

Before you were sent for, to attend the clinic at Medical Illustration, how long had you been on the Dermatology waiting list? Was it:

less than 1 month	☐	3-6 months	☐
7-9 months	☐	10-12 months	☐
13-18 months	☐	more than 18 months	☐

Q11

If more than 18 months please say how long: ☐☐ months

Q12

For many people the Skin Imaging service will mean quicker treatment and save a visit to the Dermatology Department. How happy are you to have your treatment decided by a doctor looking at the image rather than by seeing you in person?

Very Happy ☐ Quite Happy ☐ Indifferent ☐ Unhappy ☐ Very Unhappy ☐

Q13

If you have any comments on the service, please add them here:

APPENDIX 6

GENERAL PRACTITIONER ASSESSMENT OF PHOTOGRAPHIC IMAGING

Dear Doctor,
As you are possibly aware, over the last few months we have been assessing teledermatology as a diagnostic method for patients referred to the dermatology department with skin problems. At the moment this has been primarily for patients with skin tumours. We are currently analysing the results of the initiative - including diagnostic accuracy, management methods, and patient satisfaction. This clinical service, as a prelude to digital imaging and electronic transfer of information, has been undertaken using conventional photography. For the time being, pending further assessment, we are temporarily suspending the clinical teledermatology service and focusing on further research issues. We would like your views on the service and would be grateful if you would complete the following questionnaire.

GP Name and Surgery address _____

_____

1. Have any of your patients used the photographic service? Yes ☐ No ☐

2. If yes, how many: 1-5 ☐ 5-10 ☐ 10+ ☐

3. Were you happy with the following aspects of the service:

a. Length of time before patient was seen in Medical Illustration Yes ☐ No ☐
b. Length of time from photo to treatment Yes ☐ No ☐
c. Amount of information given to yourself regarding diagnosis Yes ☐ No ☐
d. Amount of information given regarding treatment Yes ☐ No ☐

4. Have you had any problems with the service? Yes ☐ No ☐

5. If so, please state

6. Would you like to see teledermatology introduced as a full service?
Yes ☐ No ☐ Not Sure ☐

Any other comments / recommendations for improvement on the teledermatology service

_____

_____

_____

APPENDIX 7

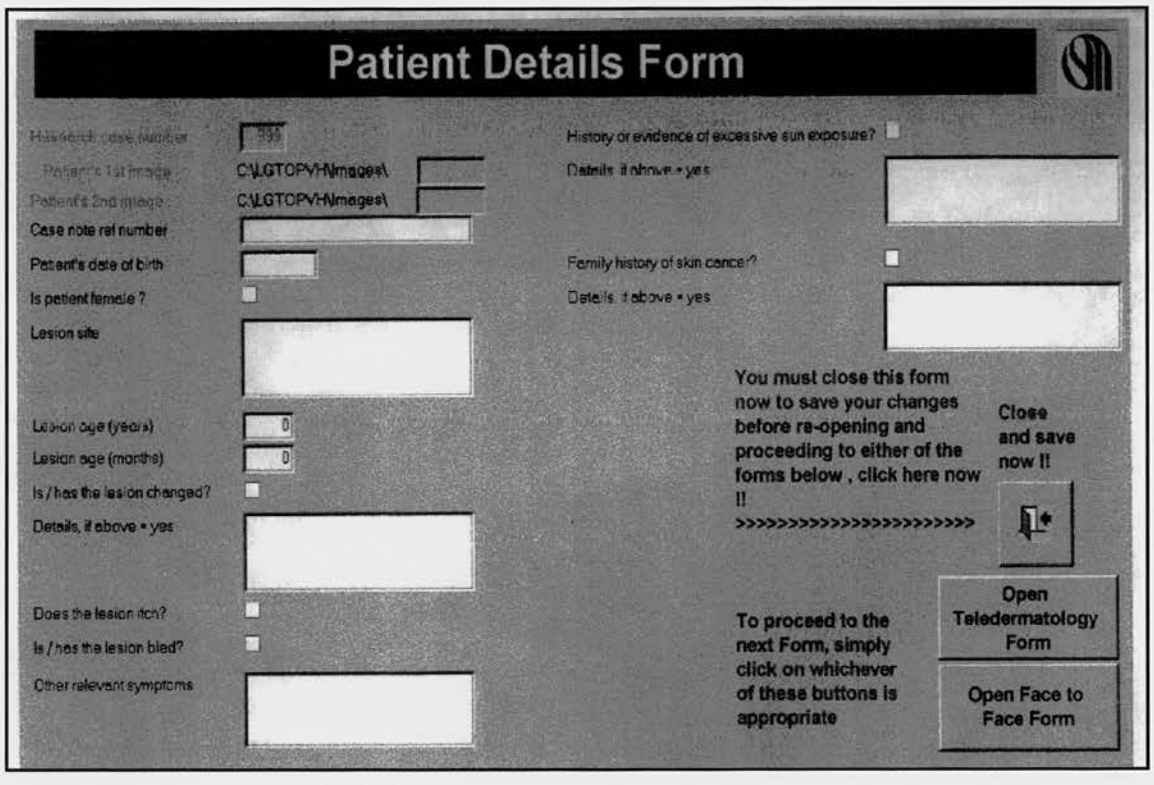
RESULTS OF GENERAL PRACTITIONERS ASSESSMENT (APPENDIX 6)

GP	How many patients have used photographic service?	Were you happy with the length of time before patient was seen?	Were you happy with the length of time from photo to treatment?	Amount of information given regarding diagnosis?	Amount of information given regarding treatment?	Have you had any problems with the service?
1	1-5	Yes	Yes	Yes	Yes	No
2	1-5	Yes	Yes	Yes	Yes	No
3	1-5	Yes	Yes	Yes	Yes	No
4	1-5	Yes	Yes	Yes	Yes	Yes
5	1-5	Yes	Yes	Yes	Yes	No
6	>10	Yes	Yes	Yes	Yes	No
7	1-5	Yes	No	No	No	No
8	1-5	Yes	Yes	Yes	Yes	Yes
9	1-5	Yes	Yes	Yes	Yes	Yes
10	>10	Yes	Yes	Yes	Yes	No
11	1-5	Yes	No	Yes	No	Yes
12	1-5	Yes	Yes	Yes	No	No
13	1-5	Yes	Yes	Yes	Yes	No
14	1-5	No	No	Yes	Yes	Yes
15	1-5	Yes	Yes	Yes	Yes	No
16	1-5	No	Yes	Yes	Yes	No
17	1-5	Yes	Yes	Yes	Yes	No
18	1-5	No	Yes	Yes	Yes	Yes
19	1-5	Yes	Yes	Yes	Yes	No
20	>10	Yes	Yes	Yes	Yes	No
21	1-5	Yes	Yes	Yes	Yes	No
22	1-5	Yes	Yes	Yes	Yes	Yes
23	1-5	Yes	Yes	Yes	Yes	Yes
24	1-5	Yes	Yes	Yes	Yes	Yes
25	1-5	Yes	No	No	No	Yes
26	1-5	No	No	Yes	No	No
27	6-10	Yes	No	Yes	Yes	Yes
28	1-5	Yes	Yes	No	No	Yes
29	1-5	Yes	Yes	Yes	Yes	Yes
30	1-5	Yes	Yes	Yes	Yes	No
31	1-5	Yes	Yes	Yes	Yes	No
32	1-5	Yes	Yes	Yes	Yes	No
33	1-5	Yes	Yes	Yes	Yes	Yes
34	1-5	Yes	Yes	Yes	Yes	No

APPENDIX 7 continued

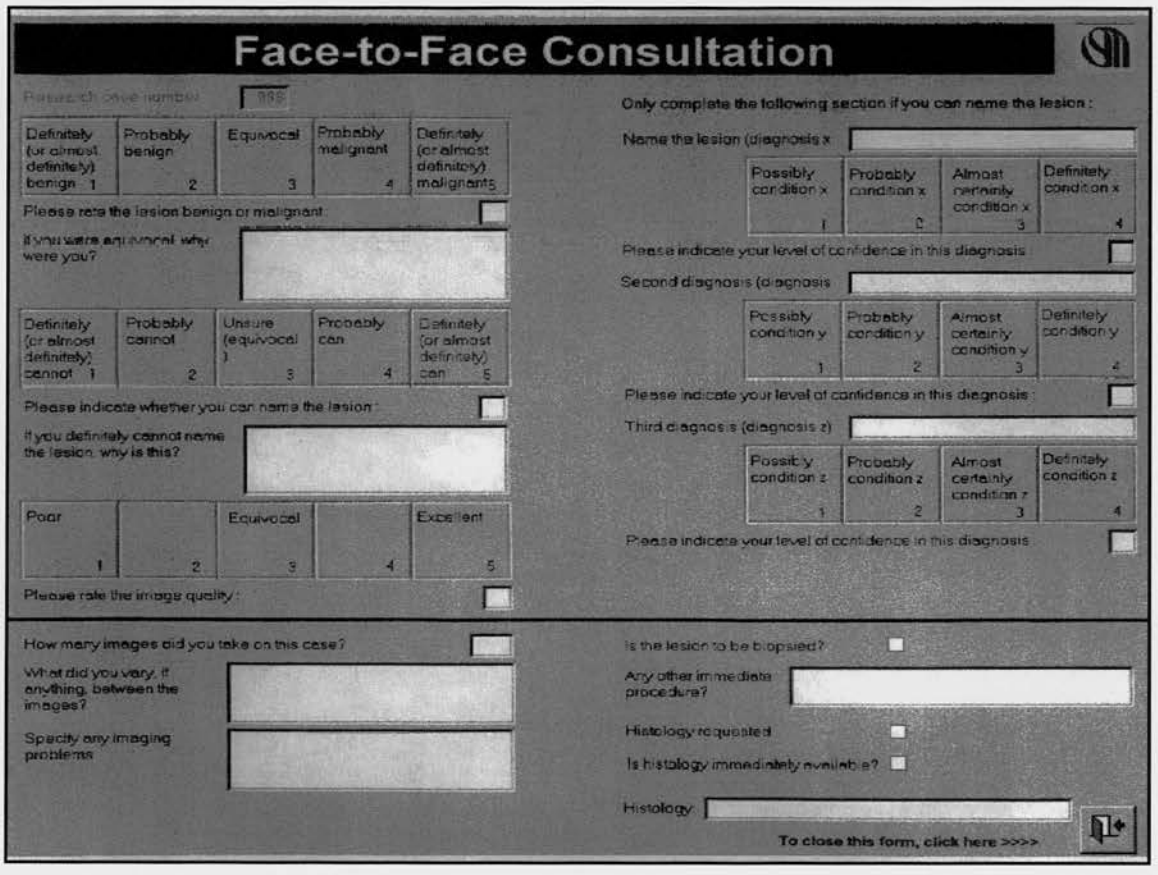
GP	How many patients have used photographic service?	Were you happy with the length of time before patient was seen?	Were you happy with the length of time from photo to treatment?	Amount of information given regarding diagnosis?	Amount of information given regarding treatment?	Have you had any problems with the service?
35	1-5	Yes	Yes	No	No	No
36	1-5	Yes	Yes	Yes	Yes	No
37	1-5	Yes	Yes	Yes	Yes	No
38	1-5	Yes	Yes	Yes	Yes	No
40	1-5	Yes	Yes	Yes	Yes	No
41	1-5	Yes	No	Yes	Yes	Yes
42	1-5	No	No	No	No	No
43	1-5	Yes	Yes	Yes	Yes	No
44	6-10	Yes	Yes	Yes	Yes	No
45	1-5	Yes	Yes	Yes	Yes	Yes
46	1-5	Yes	Yes	Yes	Yes	No
47	6-10	Yes	Yes	No	Yes	No
48	>10	Yes	Yes	Yes	Yes	No
49	1-5	Yes	No	Yes	Yes	No

APPENDIX 8.
Digital Teledermatology Database
a.) Patient details form

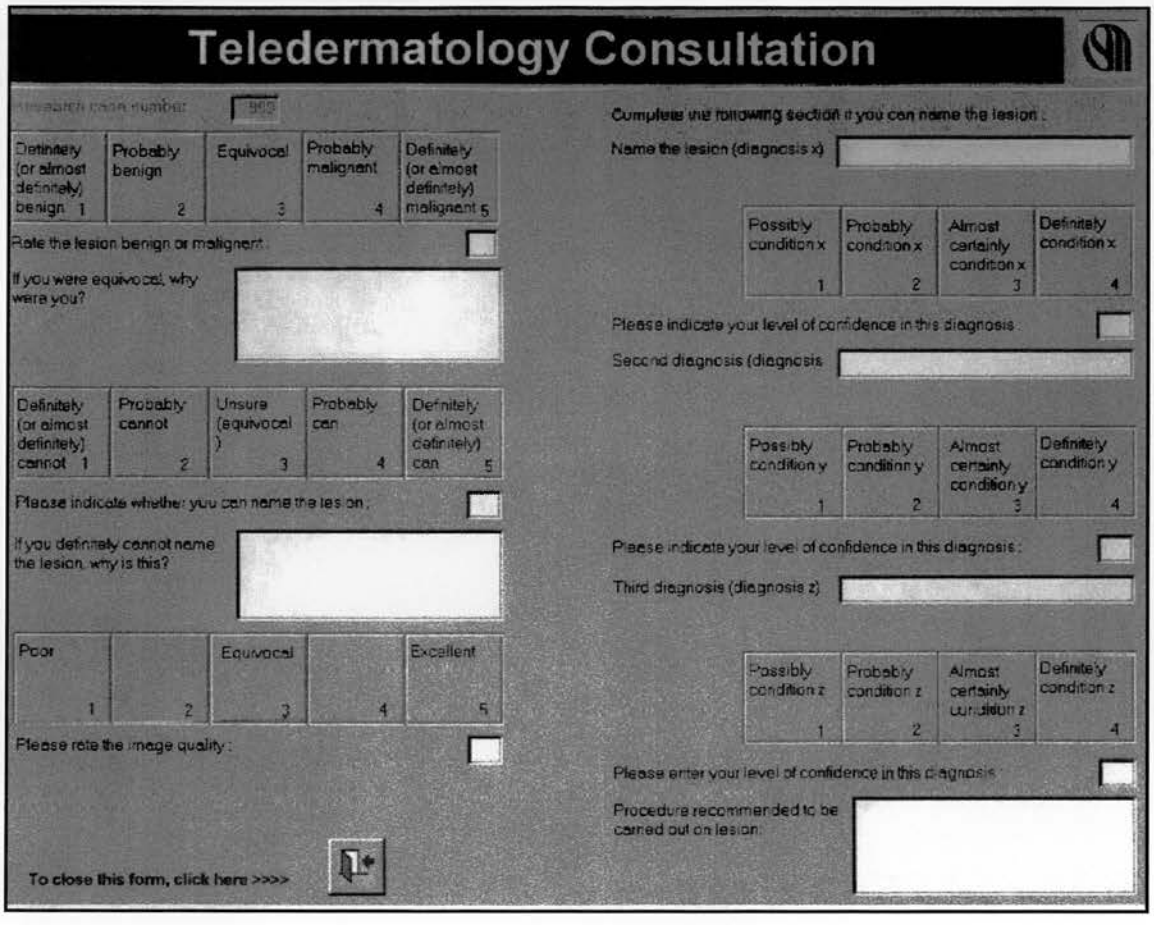


APPENDIX 8 continued
Digital Teledermatology Database

b.) Face-to-face consultation



APPENDIX 8 continued
Digital Teledermatology Database
c.) Teledermatology consultation



APPENDIX 9

PATIENT INFORMATION LETTER FOR PHOTOGRAPHIC ASSESSMENT OF SKIN TUMOURS

Dear Patient

You have been given an appointment to attend the Out-patients Department, Furness General Hospital, Barrow. This is to have a photograph taken of your skin problem, which will then be used to help in the assessment of your skin problem and to help decide what is the best management for your skin complaint.

Research has shown that interpretation of a high quality image or photograph of the skin can allow medical staff to diagnose problems and manage conditions, in much the same way as a normal clinic attendance. The advantage to the patient is speed of access to specialist advice, with minimum delay.

Hopefully you will be happy with this approach, but, if for any reason you do not want to keep this appointment, you still have the option of waiting for a standard clinic appointment in the future.

After the photograph of your skin problem, which is being used to help in your management, you will receive a letter which will indicate the proposed treatment or management of your skin problem.

Yours Sincerely

P V Harrison
Consultant Dermatologist

Date of appointment.....
Time of appointment.....
at the Out-patient Department, Furness General Hospital, Barrow.

APPENDIX 10

ASSESSMENT OF BARROW PHOTOGRAPHIC CLINIC FOR DERMATOLOGICAL PROBLEMS

Please tick the appropriate boxes for questions which require more than one answer.

Gender:-Male ☐ Female ☐ Age:- ☐

Q1 Telemedicine id described as "The use of technology to enable the diagnosis at a distance." Were you aware of this facility?

Yes ☐ No ☐

Q2 What is your view of the concept of telemedicine here at the hospital:-

Specialist advice will improve treatment
It will reduce waiting times on clinics
It will speed up the treatment
It will enable the person to be seen quicker at hospital

Q3a Have you any concerns regarding telemedicine?

Yes ☐ *Please complete Q3b*
No ☐ *Go to Q4*

Q3b Are your concerns related to:-

The accuracy with the method comparisons with the hospital clinic	Yes ☐	No ☐
Confidentiality of information	Yes ☐	No ☐
Loss of information	Yes ☐	No ☐
Being identified by picture	Yes ☐	No ☐

Q4 How long did you have to wait for an appointment at the photographic clinic after seeing your own doctor?

1 week ☐ 2-4 weeks ☐ 5-7 weeks ☐ 8-12 weeks ☐ 12+ weeks ☐

Q5 How long did you have to wait to be seen when you attended the photographic clinic?

less than 5 minutes ☐ 5-10 minutes ☐ 11-15 minutes ☐
more than 15 minutes ☐

Q6a Was it acceptable to you to be seen in the photographic clinic? ☐ Yes ☐ No

Q6b Would you have preferred to have been seen first in the dermatology clinic at the hospital rather than the photography clinic?

Yes ☐ *Please complete Q6c*
No ☐ *Go to Q7*

Q6c Whom would you have preferred to have seen?

Doctor ☐
Nurse ☐
Other health professional ☐ *Please specify:-* _____

continued overleaf.....

APPENDIX 10 continued

Q7 How did you find the photographic clinic in comparison to a standard hospital clinic?
More stressful ☐ Less stressful ☐ Just the same ☐

Q8 How many miles did you have to travel to hospital in order to attend the photographic clinic?
Less than 1 mile ☐ 1-2 miles ☐ 3-4 miles ☐ 5 miles ☐
More than 5 miles ☐

Q9 How did you get to the hospital when you attended the photographic clinic?
I walked ☐ Bicycle ☐ Motorcycle ☐ Car ☐
Bus ☐ Train ☐ Ambulance ☐ Hospital Car ☐

Q10 Were you accompanied by another person?
No ☐ *Go to Q11*
Yes ☐ *Please tick the appropriate box to indicate why you were accompanied:-*
For a physical reason to give help ☐
Moral support ☐
Strictly reassurance ☐
Accompanied by a member of the family ☐
(i.e. child accompanied by adult)

Q11 Did you take time off work, school or college for this appointment?
Yes ☐ *Please tick the appropriate box:-*
work ☐ school ☐ college ☐
No ☐

Q12 Please state your occupation:- _____

Q13 Have you been satisfied with the photographic service? Yes ☐ No ☐

Q14 How would you describe today's appointment?
I feel just the same ☐
It has reduced my anxiety ☐
It has increased my anxiety ☐
Was it because you were not sure of your diagnosis and treatment? Yes ☐ No ☐

If you wish to comment, please do so below:-

Thesis Statistics

Equipment for Document Production:

Apple G3/350 running at 350MHz with a 8Gb hard drive
ProNitron 17/550 Colour Monitor
Agfa Arcus II Colour Flatbed Scanner
Agfa T5000plus Colour Flatbed Scanner
Indigo Digital Press

Software for Document Production:

QuarkXpress 4.1
Adobe Photoshop 5.5
Illustrator 8

Document Statistics:

Document size 1.2 GB (Pages 110.5MB, Images 1089.5MB)
Average image size 1.11MB
Paper used 130g Pure Impression Silk
Set in Times New Roman
Designed and Printed by Pagefast Colour Printers
Finishing and Binding by P. Doyle (Leyland)

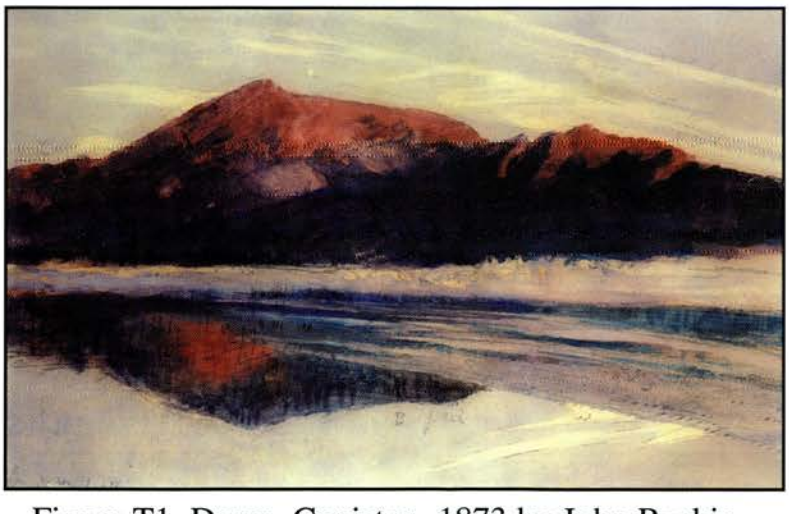


Figure T1. Dawn, Coniston, 1873 by John Ruskin.

Thesis completed Friday 25th May, 2001.